LOWER PASSAIC RIVER RESTORATION PROIJECT
BERGEN, ESSEX, HUDSON, AND PASSAIC COUNTIES, NEW JERSEY
PRE-DRAFT WORK PLAN

U.S. ARMY CORPS OF ENGINEERS CONTRACT NO. DACW41-02-D-0003

NOVEMBER 12, 2004

Note to Reviewers:

This document has not been approved by the U.S. Army Corps of Engineers or U.S. Environmental Protection Agency and is not intended for release to the public.

The purpose of this document is to lay out, in general terms, the requirements for satisfying the principal study questions for the project. Many of our Technical Advisory Committee members have reviewed an earlier version of this document and provided input and comment which has been used by the project team in developing this version for broader agency and stakeholder review.

As the purpose of this pre-draft is to generate discussion towards a consensus, reviewers are requested to remember that many sections and elements are not in their final forms – and are not intended to be so. Input and comment as a collaborative team is desired to help us refine the rationales and approaches to be taken and to consider the program from as many perspectives as possible before the frequency and locations of measurements to be taken are determined.

Once there has been opportunity for initial review, there will be a consensus meeting where reviewers may provide initial comments verbally and ask for clarification as needed. Insofar as possible, it is hoped that consensus on the major issues will be reached at this meeting. Then, written comments from all reviewers will be compiled by EPA and used by the technical team to improve or modify the program and to prepare the Draft WP. There will be additional opportunity to review the Draft documents thus generated with further discussion prior to generating the final document to be approved by EPA to guide the investigation.

1.0 INTRODUCTION

1.1 Overview

This Work Plan (WP) presents the technical approach for conducting the Phase 2 work activities for the Remedial Investigation/Feasibility Study (RI/FS) for the Lower Passaic River Restoration Project Study Area. This WP is a dynamic document that will be expanded as the project evolves and additional phases of work are initiated.

The three phases of the RI/FS that have currently been identified include:

- Phase 1: Preliminary Data Evaluation and Site Characterization
- Phase 2: Remedial Investigations and Further Site Characterization (this WP)
- Phase 3: Remedial Feasibility Studies

The Lower Passaic River Restoration Project Study Area (hereafter referred to as the Study Area) includes the 17-mile tidal reach of the Passaic River below the Dundee Dam, including the tidal portion of its tributaries (*e.g.*, Saddle River, Second River, and Third River). Refer to Figure 1-1 for a Site Location Map. The Study Area is a portion of the Passaic River Estuary, which also includes all major influences to the Study Area, including the Hackensack River up to the Oradell Dam, Berry's Creek, Pierson Creek, Newark Bay, and the Arthur Kill and Kill van Kull.

1.2 Phase 2 Purpose and Objectives

The objectives of the Phase 2 work activities are to:

- obtain data to prepare the RI/FS report for the Study Area
- obtain data to develop human health and ecological risk assessments for the Study Area
- support a comprehensive, watershed-based plan to restore the functional and structural integrity of the Lower Passaic River ecosystem and to support broader, watershed-wide restoration efforts under the Water Resources Development Act (WRDA)

Further discussion of the Phase 2 objectives is provided in Section 4.0, Work Plan Rationale and in the Data Quality Objectives provided in the Quality Assurance Project Plan.

To date, numerous investigations, including environmental sampling, have been conducted in parts of the Lower Passaic River by various entities having differing objectives. Phase 1 of this RI focused on compiling and evaluating existing data prior to advancing with significant additional work. The results of Phase 1 for the surface sediment are included in this WP as Section 3.0.

The results of the Phase 1 data evaluation activities have been used to initiate the Phase 2 activities through completion of this WP; the Sampling and Analysis Plan (SAP), which includes a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP); the Modeling Plan; and the Pathways Analysis Report (PAR). In general, the Modeling Plan, the PAR, and the data quality objectives (DQO) outlined in the QAPP identify data that are necessary to complete the RI/FS. These needs are compared to the available historical data and the data gaps are identified. The required data and field tasks are then identified and described in this WP and the FSP.

The field investigations in Phase 2 will center primarily on the 17 miles of the Lower Passaic River and its tributaries (the Study Area), but will also extend, as appropriate, into connected water bodies such as the Hackensack River and its tributaries, Newark Bay, Arthur Kill, and the Kill van Kull. This work will take into account complementary efforts being conducted by Tierra Solutions, Inc. (TSI), which is under an Administrative Order of Consent (AOC) with the U.S. Environmental Protection Agency (USEPA) to conduct work in Newark Bay, as well as work being conducted at the direction of USEPA in Berry's Creek.

1.3 Site Background and History

The Passaic River Estuary has a long history of industrialization, dating back more than two centuries. By the beginning of the twentieth century, Newark was the largest industrial-based city in the United States with well-established industries such as petroleum refining, shipping, tanneries, creosote wood preservers, metal recyclers, and manufacturing of materials such as rubber, rope, textiles, paints and dyes, pharmaceuticals, raw chemicals, leather, and paper products. Both World War I and World War II promoted further urban and industrial growth in the region. In addition, Newark's growing prominence as an industrial center was associated with a rapidly expanding population, resulting in the generation of increasing volumes of human wastes. The Passaic River Estuary remains a heavily industrialized waterway, especially in the portion that runs through Newark, Harrison, and Kearney. Figures 1-2 and 1-3 show Superfund Sites on the National Priorities List (NPL) and facilities regulated pursuant to RCRA within the Passaic River Estuary, respectively.

Despite the development of sewage treatment plants, many industrial facilities located along the Passaic River were not connected to the Passaic Valley Sewerage Commissioners (PVSC) trunk line until the late 1950s. Contamination of the Passaic River Estuary is a direct result of the industrialization and the associated point and non-point discharges to the river, which have caused water and sediment quality in the Passaic River Estuary to deteriorate. There are numerous National Pollutant Discharge Elimination System (NPDES) permit discharges into the river (www.state.nj.us/dep/gis) and there are also more than 100 identified potential hazardous waste sources in the watershed (www.state.nj.us/dep/gis and www.epa.gov/region02/gis/data.htm). Water and sediment quality problems in the Passaic River Estuary have contributed to ecosystem degradation in the river, as well as to ecosystem degradation in the adjacent waters of Newark Bay and Upper and Lower New York Bay. Figures 1-4 and 1-5 show the locations of combined sewer outfalls (CSOs) within the area of the Passaic River Estuary.

Numerous potentially responsible parties (PRPs), which may have contributed to the contamination in the Passaic River Estuary, have been identified. One PRP site in the Passaic River Estuary that has been the subject of historic and ongoing CERCLA program efforts is the Diamond Alkali Superfund Site. Operable Unit 1 (OU1) of the Diamond Alkali Site includes the upland properties located at 80 and 120 Lister Avenue in the Ironbound section of Newark, New Jersey. Hazardous substances from OU1 migrated to Operable Unit 2 (OU2) of the Diamond Alkali Site, which was initially identified as the six miles of the Passaic River down-estuary of the Diamond Alkali Superfund Site, and referred to as the Passaic River Study Area (PRSA). In this WP, the term PRSA will only be used in discussions of previous CERCLA efforts for the Diamond Alkali site to avoid confusion with the Study Area that is the subject of this WP and RI/FS effort. OU2 was later expanded to the entire 17-mile stretch of the Passaic River down-estuary of the Dundee Dam, which is equivalent to this WP's Study Area. Figure 1-2 shows the location of the Diamond Alkali Superfund Site. The history of the Diamond Alkali Superfund Site is described in Table 1-1.

From the 1940's through the 1960's, phenoxy-herbicides were manufactured at the Diamond Alkali Superfund Site. Although other industries have also discharged polychlorinated Dibenzo-p-dioxins (PCDD) and other chemicals in their waste effluent, their contributions to anthropogenic contamination are not well known.

In 1994, Occidental Chemical Company (OCC)[1] entered into AOC Index No. II-CERCLA 94-0177 with USEPA. Chemical Land Holdings (CLH), now known as TSI, on behalf of OCC, designed and executed an RI/FS Work Plan (CLH, *RI/FS Work Plans for the Passaic River Study Area*, January 1995), which addressed the contaminated sediments of the Passaic River in the vicinity of the OCC facility. The RI/FS primarily focused on the original six-mile PRSA between the abandoned ConRail Railroad bridge[2] and the Diamond Alkali Site.

1 OCC is a successor of the Diamond Alkali Company (aka as the Diamond Shamrock Chemicals Company)

2 This is about 0.8 miles above the Passaic River's confluence with Newark Bay

TABLE 1-1

LOWER PASSAIC RIVER RESTORATION PROJECT

DIAMOND ALKALI SUPERFUND SITE HISTORY

1951	• Diamond Alkali Company begins operations at a plant at 80 Lister Avenue. Production activities include the manufacturing of chemicals including: 2,4-Dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxy)acetic acid (2,4,5-T), and 2,4,5-trichlorophenol.
1967	• Diamond Alkali Company becomes Diamond Shamrock Corporation.
1969	• Diamond Shamrock Corporation ceases production activities.
1971	• Diamond Shamrock Corporation sells 80 Lister Avenue to Chemical and Corporation.
1980	• Chemical and Corporation sells 80 Lister Avenue to Walter Ray Holding Company.
1981	• Walter Ray Holding Company sells 80 Lister Avenue to Marisol, Inc.
1983	• The Diamond Shamrock Corporation adopts a new corporate structure. A stock holding company is formed under the name "Diamond Shamrock Corporation." The former Diamond Shamrock Corporation changes its name to Diamond Shamrock Chemicals Company, and becomes a subsidiary of the new Diamond Shamrock Corporation. • As a result of USEPA's National Dioxin Strategy, which targeted facilities that produced 2,4,5-trichlorophenol and/or its pesticide derivatives for sampling, the 80 Lister Avenue property is sampled for dioxin. Dioxin and other hazardous substances are also subsequently found at other properties in the area and in biota and sediment samples from the river. To address the off-site contamination, USEPA, under the removal authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the N.J. Department of Environmental Protection (NJDEP) initiates a number of clean-up activities. Removal actions include: vacuuming contaminated streets; excavating contaminated soil; fencing the site; 24-hour guard service; and storing the vacuumed/excavated material (10,495 cubic yards) in 932 cargo containers on the 120 Lister Avenue portion of the site. In addition, the ground surface at the site is covered with a geotextile material and debris piles are covered with geosynthetic liners to mitigate direct contact with the contaminated soil, minimize surface erosion of contaminated soil into the river, and control migration of contaminated dust. • The Lister Avenue property is proposed for the Superfund NPL.
1984	• The NJDEP issues an AOC which requires Diamond Shamrock to perform a Site Evaluation and FS, as well as other response actions, for the 80 Lister Avenue property. • Diamond Shamrock Chemicals Company acquires the property located at 120 Lister Avenue from E.M. Sergeant Pulp and Chemical Co., Inc. to assist with the cleanup of the 80 Lister Avenue property. • The property is added to the NPL. • The NJDEP issues a second AOC to Diamond Shamrock requiring completion of the removal program's clean-up actions, as well as a Site Evaluation for the 120 Lister Avenue property. The order also requires that the FS be expanded to include 120 Lister Avenue.
1985	• The Site Evaluations for 80 and 120 Lister Avenue, which together constitute the RI for OU1, are completed. • Diamond Shamrock Chemicals Company prepares an FS for OU1.

TABLE 1-1 LOWER PASSAIC RIVER RESTORATION PROJECT DIAMOND ALKALI SUPERFUND SITE HISTORY	
1986	• Diamond Shamrock Corporation sells all the outstanding stock in Diamond Shamrock Chemicals Company to Oxy-Diamond Alkali Corporation, a wholly-owned indirect subsidiary of Occidental Petroleum Corporation. Diamond Shamrock Chemicals Company is then renamed Occidental Electrochemicals Corporation. • Diamond Shamrock Chemicals Company acquires the plant and property at 80 Lister Avenue from Marisol, Inc. to assist in the cleanup. Title to the 80 and 120 Lister Avenue properties had previously been transferred by way of an intra-holding company transaction to Diamond Shamrock Chemical Land Holdings, Inc. • The FS for OU1 is finalized pursuant to NJDEP and USEPA comments.
1987	• Occidental Electrochemicals Corporation merges into OCC, a wholly-owned indirect subsidiary of Occidental Petroleum Corporation. In addition, the name of Diamond Shamrock Chemical Land Holdings, Inc. changes to Chemical Land Holdings, Inc. • USEPA proposes an interim remedial action for OU1. USEPA also deemed it necessary to create OU2 to address contamination in the Passaic River. • USEPA issues a Record of Decision (ROD) for OU1, selecting the interim remedy. The interim remedy calls for containment via engineering controls including a cap, slurry wall, and flood wall around the properties and ground water pumping and treating to reduce the migration of contaminated ground water. The interim remedy also requires an FS to be conducted every two years after construction completion to develop, screen, and assess remedial alternatives, evaluate the performance of the containment remedy, and evaluate new and alternative technologies.
1988	• USEPA and the NJDEP enter into negotiations with the PRPs for the design and implementation of the interim containment remedy.
1990	• USEPA, NJDEP, and OCC enter into a Consent Decree requiring design and implementation of the interim remedy and the reimbursement of response costs.
1993	• OCC submits the Remedial Design Work Plan
1994	• USEPA approves the Remedial Design Work Plan. • Design work specified in the Remedial Design Work Plan is performed, and reported to USEPA for review in the form of the following reports: Remedial Design Investigation Report, Treatability Study Report, Preliminary (30%) Design Report, Pre-Final (90%) Design Report, and Final (100%) Design Report. • USEPA and OCC enter into an AOC regarding the 80 and 120 Lister Avenue property and the Passaic River.
1997	• USEPA approves the 100% Design Report.
1999	• As permitted by the Consent Decree, OCC hires the construction contractor and submits requests for design modifications.
2000	• Construction at OU1 begins.
2001	• Construction at OU1 is complete. The contamination contained on the 80 and 120 Lister Avenue is completely cut off from the Passaic River.

Sediments in the Study Area are contaminated with a variety of substances including dioxins, polychlorinated biphenyls (PCBs), pesticides, total extractable petroleum hydrocarbons (TEPHs), polycyclic aromatic hydrocarbons (PAHs), and metals. The contaminated sediments are of concern to various federal and state regulatory agencies due to their potential to cause:

- Ecological health effects
- Human health effects[3]
- Economic impacts on navigational dredging disposal costs

As water quality, sediment quality, and biological data from the CLH RI/FS have become available, the scientific understanding of the Passaic River Estuary has evolved and the potential importance of the inter-relationship between tidal Study Area and the Hackensack River - Newark Bay system has become apparent. Also during this period the U.S. Congress directed USEPA to have the National Academy of Science/National Research Council (NRC) review, select and refine a scientific, risk-based framework for assessing the remediation alternatives to mitigate exposure of humans and other living organisms to PCBs[4] in contaminated sediments (NAS/NRC, *A Risk-Management Strategy for PCB-Contaminated Sediments,* March 2001). Furthermore, the NJDEP has initiated a watershed-based total maximum daily load (TMDL) effort for the upper Passaic River.

In 2001, the USACE began drafting the Lower Passaic River Ecosystem Restoration Project Management Plan (PMP) in consultation with USEPA, as a 'living document'.

3 Due to the contamination, the NJDEP instituted a 'do not eat' advisory/prohibition for both fish and shellfish in 1983. This advisory is currently still in effect. In August 2004, NJDEP conducted fish sampling in order to update the advisory, if necessary. These data are not yet available. (http://www.state.nj.us/dep/dsr/njmainfish.htm, last accessed September 28, 2004).
4 The NRC report was completed in mid 2001 and though it focuses primarily on assessment of PCB contaminated sediments, much of the information in the report has been judged to be applicable to other sediment contaminants, especially the hydrophobic chemicals found in the Passaic River sediments (*e.g.,* dioxin, pesticides).

USEPA, recognizing the importance of looking at the Lower Passaic River as an integral component of the Lower Passaic River - Hackensack River - Newark Bay system, has made a commitment to better understand this system to create a scientific basis for evaluating potential remedial solutions. The potential benefits of addressing the environmental concerns facing the Lower Passaic River via a unified watershed approach are that the primary contaminants of concern can be addressed more cost- and time-effectively.

During the summer of 2001 the U.S. Army Corps of Engineers (USACE), New York District (NYD) completed a reconnaissance survey of the Lower Passaic River, as part of their Hudson-Raritan Estuary Restoration Initiative. The purpose of the reconnaissance study was to identify and inventory water resources and sediment quality-related problems and needs in the Hudson-Raritan Estuary. The reconnaissance study identified the Passaic River Estuary as one of the priority restoration areas within the Hudson-Raritan Estuary. This area includes the Study Area and all its influences. The preliminary assessment of water resource problems and needs in the Passaic River Estuary identified extensive habitat loss and degradation that has greatly reduced the functional and structural integrity of ecosystems within the study area and limits the recreational and economic use of the river. To address this problem, the USACE – NYD, under WRDA, will develop a comprehensive watershed-based plan for the Passaic River Estuary.

2.0 SITE BACKGROUND

1.4 Site Area Conditions

1.4.1 Geologic Setting

The Study Area is situated within the Newark Basin portion of the Piedmont physiographic Province, which is located between the Atlantic Coastal Province and the Appalachian Province. The Newark Basin is underlain by sedimentary rocks (sandstones. shales, limy shales, and conglomerates), igneous rocks (basalt and diabase), and metamorphic rocks (schists and gneiss). These rocks are from the mid-Triassic to early Jurassic periods. Bedrock underlying the Study Area is the Passaic Formation (Olsen *et al.* 1984; Nichols 1968), which consists of interbedded red-brown sandstones and shales.

Almost the entire Passaic River Basin, including the Study Area, was subjected to glacial erosion and deposition as a result of the last stage of the Wisconsin glaciation. Considerable quantities of stratified sand, silt, gravel and clay were deposited in a glacial lake covering the area. These glaciofluvial deposits overlie bedrock and underlie the meadowlands section of the Newark Basin.

1.4.2 Surface Water Hydrology

The majority of the freshwater inflow to the Lower Passaic River (approximately 1,200 cubic feet per second [cfs] on average) is provided by the upper portion of the river (USACE, 1987; USGS, 1989). The Third River, a tributary which discharges to the Lower Passaic River approximately 6 miles down-estuary of the Dundee Dam, contributes on average, an additional 21 cfs. Additional freshwater inflow can also come from three ungauged tributaries located down-estuary of the Third River, namely the Second River, Franks Creek and Lawyers Creek, and from urban runoff, including storm sewers and CSOs (Figures 1-4 and 1-5). Details of the CSOs down-estuary of the Dundee Dam, including the CSO name, location and receiving water body are provided in Table 2-1 and Figures 1-4 and 1-5. According to Suszkowski (1978) the ungauged flows between the Dundee Dam and Newark Bay contribute less than 10% of the total flow at the mouth of the Passaic River. Water quality in the Lower Passaic River is rated very poor in the freshwater regime above the Dundee Dam, and in the saline tidal reaches below the dam (USACE 1987).

The Lower Passaic River is influenced by tidal flows for approximately 17 miles extending from Dundee Dam down-estuary to the confluence with Newark Bay. The mean tidal range (difference in height between mean high water and mean low water) at the New Jersey Turnpike Bridge (approximately 15 miles up-estuary from Newark Bay) is 5.1 feet (NOAA 1972) with a mean tide level (midway between mean low water and mean high water) at elevation 2.5 feet (NOAA 1972). The mean spring tide range (average semi-diurnal range occurring during the full and new moon periods) is 6.1 feet. Saline water conditions exist throughout much of the Study Area. The cross-sectional average river velocity due to freshwater flow in the Study Area is approximately 1 foot per second with a typical maximum tidal velocity of approximately 3 feet per second (USACE 1987). The velocities resulting from up-estuary freshwater flow conditions will not normally control the resuspension of bottom sediments (USACE 1987).

1.4.3 Climate

The information provided by USACE (1987) indicate that the climate for the Study Area and surrounding area is characteristic of the Middle Atlantic Seaboard where marked changes in weather are frequent, particularly in the spring and fall. Winters are moderate with snowfall averaging approximately 34 inches annually from October through mid-April. Rainfall is moderate and distributed fairly uniformly throughout the year, averaging approximately 47 inches annually with an average of 121 rainy days per year, although the region may be influenced by seasonal tropical storms and hurricanes between June and November. Thunderstorm activity is most likely to occur in the summer, and northeasters, which bring strong northeast winds over the East as they move north along the Atlantic Coast leading to heavy rain, snow and coastal flooding, usually occur from November to April. The average annual temperature in Newark is 54 degrees Fahrenheit (^{o}F) with extremes from -26 ^{o}F to + 108 ^{o}F. Mean relative humidity varies from 67% to 73%. Prevailing winds in the Newark area are from the southwest with only small seasonal variations in direction. The mean wind direction for the winter months is west-northwest (13% of the time) while southwest winds (12% of the time) predominate during the summer. Mean wind speeds are generally highest during the winter and spring months (10 to 12 miles per hour), and lower (8 to 9 miles per hour) during the summer months with an average annual velocity of approximately 10 miles per hour.

1.4.4 Shoreline Features

Both shorelines of the Lower Passaic River are almost completely developed, consisting of commercial and industrial properties as well as man-made recreational areas. Actual hydrological perspective is from up stream/up River view. Left Bank is left descending and right, right descending. Using continuous below is technically wrong but as long as it's used "wrong" consistently, maybe not a problem. For the purpose of this document, the shoreline of the Lower Passaic River will be defined as left and right shorelines from the perspective of standing on the Dundee Dam and looking down river toward Newark Bay. The thalweg (deepest part of the river channel) of the river is generally in the center of the channel in straight sections and is observed to favor the outside bends of the meanders. The Lower Passaic River encompasses four complete navigational reaches (Point No Point, Harrison, Newark, and Kearny Reaches) and one partial USACE defined navigational reach (Upstream Reach). Refer to Figure 3-1 for a map showing the locations of the reaches.

1.4.5 River Miles and Reaches

There have been many studies to date done on and along the Lower Passaic River by various entities with different goals. Along with the large amount of data produced came differing, and sometime conflicting, coordinate systems and references to River Miles (RM). For the previous TSI study, RM 0.0 was located at the abandoned ConRail Railroad Bridge, which is located approximately 4,000 feet up-estuary from the red channel junction marker at the confluence of the Passaic River and Newark Bay. This RM 0.0 is approximately 4,000 feet up-estuary of the RM 0.0 which has been established for this project (Plate 1). The RM 0.0 established for the Lower Passaic River Restoration Project uses two light houses, one located in Essex County, NJ and the other located on Kearny Point in Kearny, NJ, as markers. From these light houses an imaginary line was drawn which became RM 0.0.

Point No Point Reach

The Point No Point Reach extends from the down-estuary river boundary RM 0 to approximately RM 2.2 of the Lower Passaic River. The reach follows a north-south trend and is the deepest portion of the Study Area. The only major natural inflow is Lawyer's Creek, a small drainage that enters from the left bank approximately 3,000 feet from the up-estuary end of the reach. The reach contains three bridges including the abandoned ConRail Bridge that delineates the lower portion of the Diamond Alkali PRSA, the Lincoln Highway, and the General Pulaski Skyway Bridges (U.S. Routes l & 9).

The USACE is responsible for delineating and maintaining navigation channels in the Lower Passaic River. The Federal Project Limit was originally adopted in 1907 (modified in 1911, 1912, and 1930) to maintain a channel that is 30 feet deep (relative to mean low water (MLW)) and 300 feet wide in the Point No Point Reach (USEPA, 1995).

The last available USACE hydrographic survey was performed in 1989 to assess the conditions of the river. Water depths in the Point No Point Reach ranged from approximately 33.0 feet MLW at the down-estuary end to 21.1 feet MLW at the up-estuary end. The channel in the Point No Point Reach was last dredged in 1983 to the Project Depth of 30 feet. Previous dredging events in the period of interest are reported in 1940, 1946, 1957, 1965, and 1971 (IT 1986).

The shorelines of the reach consist primarily of wooden and stone bulkheads and are bordered by several industrial facilities. The left shoreline contains several large industrial facilities including Western Electric, Badische Anilin- & Soda-Fabrik AG (BASF), SpectraServe, and a former Monsanto manufacturing plant. The right shoreline consists of mostly wooden bulkheads and contains ship piers, several chemical and petro-chemical manufacturing facilities (including Reichold Chemical, Sun Oil, and Hoescht-Celanese), and the former Public Service Electric and Gas Company's (PSE&G) Essex Generating Station.

Harrison Reach

The Harrison Reach extends from approximately RM 2.2 to RM 4.4 of the Study Area. Based on the hydrographic survey conducted by USACE in 1989, water depths range from 21.1 feet MLW at the down-estuary end of the reach to approximately 19.2

feet MLW at the up-estuary end. In general, areas of higher deposition are observed on the inside bend of the meanders rather than the outside bends.

Two bridges are located in the Harrison Reach and are positioned close together near the down-estuary end of the reach. Looking up-estuary, the first bridge is a ConRail (Penn Central) Freight Bridge and the second is the bridge for Interstate 95 (New Jersey Turnpike).

The USACE has delineated the Federal Project Limits for the Reach as a 300-foot wide channel with a project depth of 20 feet MLW. The only dredging event in the Harrison Reach within the period of interest was performed in 1949 with a project depth of 20 feet.

The left shoreline consists primarily of gravel rip-rap and wooden, or stone, bulkheads bordered by a passenger train yard and a train servicing depot. The right shoreline consists of wooden bulkheads bordered by several chemical facilities (*e.g.*, Benjamin Moore, Chemical Waste Management, Hilton-Davis, Sherwin-Williams, and inactive industrial properties including Commercial Solvents and Diamond Shamrock). An abandoned marina is located at Blanchard Street between the abandoned Commercial Solvents site and the Benjamin Moore facility.

Newark Reach

The Newark Reach extends from approximately RM 4.4 to RM 5.8 of the Study Area and runs through the downtown section of the City of Newark. This Reach begins in an east-west direction and slowly curves in a northerly direction.

The Newark Reach contains numerous bridges. Looking up-estuary the bridges include: Jackson Street Bridge, Amtrak Railroad Bridge, Harrison Avenue Bridge, ConRail Freight Railroad Bridge, William Stickel Memorial Bridge, and Clay Street Bridge, which delineates the up-estuary extent of the Newark Reach. The former Center Street Bridge was located between the Amtrak and Harrison Avenue Bridges, however, this bridge has since been abandoned and the bridge piers removed.

The USACE has designated the Federal Project Limits as 300 feet wide in the Newark Reach with a project depth of 20 feet MLW. Dredging in this reach was performed in 1949 to a project depth of 16 feet MLW. The last hydrographic survey was performed in 1989 and showed that channel depths in the Reach range from 19.2 feet MLW at the down-estuary end to 18.7 feet MLW at the up-estuary end.

The left shoreline consists of wooden, metal, or stone bulkheads bordered by oil storage tanks, numerous small manufacturing facilities, and a former coal burning facility near the Jackson Street Bridge. The right shoreline consists of parking lots and wooden, or stone, bulkheads bordered by a small park alongside Highway 52 (fenced on the river side).

Kearny Reach

The Kearny Reach extends from approximately RM 5.8 to RM 6.8 in the Study Area. The Reach begins in a general north-south direction and then curves to the northeast. The reach contains two bridges: the aforementioned Clay Street Bridge that delineates the boundary between the Newark and Kearny Reaches and a former Erie & Lackawanna Railroad Bridge. The railroad bridge is abandoned in the open position.

The USACE has designated the Federal Project Limits for the Kearny Reach as 300 feet wide with a project depth of 20 feet MLW. Dredging in this reach was performed in 1949 to a project depth of 16 feet MWL. Based on the 1989 hydrographic survey, channel depths range from 18.7 feet MLW at the down-estuary end of the Reach to 17.0 feet MLW at the up-estuary end.

The right shoreline consists primarily of stone bulkheads and is bordered by train tracks serviced by ConRail and Highway 22 (McCarter Freeway) leading northward from downtown Newark. The ConRail train tracks end at the site of the former PPG manufacturing plant located along the left shore of Kearny Reach. The left t shore of the Kearny Reach consists of wooden and stone bulkheads bordered by several small manufacturing facilities.

Upstream Reach

The Upstream Reach extends from approximately RM 6.8 to the Dundee Dam. The river direction does not change appreciably in the Upstream Reach. The USACE has delineated the Federal Project Limits as 200 feet wide in the Upstream Reach with a project depth of 16 feet MLW. Dredging in the navigable portion of this reach was performed in 1949 to a project depth of 16 feet MLW. Based on the 1989 hydrographic survey, the channel depth in the Reach is 17.0 feet MLW.

The left shoreline of the Upstream Reach consists of wooden and stone bulkheads bordered by several small manufacturing facilities and some private homes at the northern end of the Study Area. The right shore of the Upstream Reach consists primarily of parking lots.

3.0 PRELIMINARY EVALUATION

A preliminary evaluation of historical sediment quality data was conducted for the Lower Passaic River Restoration Project Study Area (MPI, 2004). This evaluation focused on surface sediment results; subsurface sediment concentrations were only evaluated within the area where the highest surface concentrations were found. The objectives of the evaluation were to:

- Provide a preliminary quality review of the existing data in the Passaic River Estuary Management Information System (PREmis) using an established data quality scheme.
- Provide a preliminary review of the existing Passaic River sediment data to characterize the nature and extent of sediment contamination and identify a preliminary list of benchmark chemicals. The benchmark chemicals are a subset of the chemicals of potential concern (COPCs) identified for the project as part of the risk assessment process (Battelle, under contract to Malcolm Pirnie, Draft Pathways Analysis Report for the Lower Passaic River Restoration Project, June 2004). Refer to Tables 3-1 through 3-2 for a list of COPCs identified during the preliminary pathways analysis. The purpose of identifying benchmark chemicals is to produce a focused list of chemicals used to aid in determining sampling locations as part of the field investigation. While the benchmark chemicals will be used to establish sampling locations, the COPC list will be used to establish the analytical list.

The preliminary evaluation for benchmark chemicals consisted of statistical analyses of chemicals in surface sediments, as well as a preliminary screening of sediment concentrations against established sediment quality guidelines (SQGs). For a detailed description of the evaluation process refer to Malcolm Pirnie, *Draft Historical Data Evaluation for the Lower Passaic River Restoration Project*, May 2004.

It should be noted that all of the data used in this evaluation were collected at least 4 years ago; the majority of the data were collected prior to 1999. Therefore, these data may not be representative of current surface conditions[5]. To determine how the bottom of the Lower Passaic River has changed with time, a comparison of bathymetric data currently (Fall 2004) being collected by USACE-NYD and bathymetric data collected by USACE-NYD in 1989 will be conducted.

5 It should be noted that Hurricane Floyd went through New Jersey in September 1999 (http://www.dl.stevens-tech.edu/davidson/floyd/, last accessed October 20, 2004).

Table 3-1
Lower Passaic River Restoration Project
List of Sediment COPCs Identified in PAR

Analyte	Study Area	Lower 6 Miles	Upper 11 Miles
INORGANICS			
Aluminum	X	X	X
Antimony	X	X	X
Arsenic	X	X	X
Barium	X		X
Cadmium	X	X	X
Chromium	X	X	X
Copper	X	X	X
Cyanide	X	X	
Lead	X	X	X
Manganese	X	X	X
Mercury	X	X	X
Nickel	X	X	X
Silver	X		X
Thallium	X	X	X
Titanium	X	X	X
Vanadium	X	X	
VOCs			
Benzene	X	X	X
TPH	X	X	X
Vinyl chloride	X	X	X
SVOCs			
Bis(2-Ethylhexyl)phthalate	X	X	
Dibenzofuran	X	X	
Dibenzothiophene	X	X	X
Dibutyltin	X	X	X
Di-n-butyl phthalate	X	X	
Monobutyltin	X	X	X
Tetrabutyltin	X	X	
Tributyltin	X	X	X
PAHs			
1,4-Dichlorobenzene	X	X	X
1-Methylnaphthalene	X	X	X
1-Methylphenanthrene	X	X	X
2,3,5-Trimethylnaphthalene	X	X	X
2,6-Dimethylnaphthalene	X	X	X
2-Methylnaphthalene	X	X	X
Acenaphthene	X	X	
Acenaphthylene	X	X	X

Table 3-1 (continued)
Lower Passaic River Restoration Project
List of Sediment COPCs Identified in PAR

Benz[a]anthracene	X	X	X
Benzo[a]pyrene	X	X	X
Benzo[b]fluoranthene	X	X	X
Benzo[e]pyrene	X	X	X
Benzo[g,h,i]perylene	X	X	X
Benzo[k]fluoranthene	X	X	X
Biphenyl	X	X	X
Chrysene	X	X	
Dibenz[a,h]anthracene	X	X	X
Fluoranthene	X	X	
High Molecular Weight (HMW) PAHs	X	X	X
Indeno[1,2,3-c,d]-pyrene	X	X	X
Low Molecular Weight (LMW) PAHs	X	X	X
Naphthalene	X	X	X
PAHs, Total	X	X	X
Perylene	X	X	X
Phenanthrene	X	X	X
Pyrene	X	X	
PCBs			
Total PCBs (Aroclors)	X	X	X
Total PCBs (Congeners)	X	X	X
PESTICIDES/HERBICIDES			
4,4'-DDD	X	X	
4,4'-DDT	X	X	
DDTS, total of 6 isomers	X	X	
Aldrin	X		X
Dieldrin	X	X	X
Total Endrin	X	X	X
DIOXINS			
2,3,7,8-TCDD	X	X	X

Table 3-2
Lower Passaic River Restoration Project
List of Tissue COPCs Identified in PAR

Analyte	Study Area	Lower 6 Miles	Upper 11 Miles
INORGANICS			
Aluminum	X	X	
Antimony	X	X	X
Arsenic	X	X	X
Barium	X	X	
Cadmium	X	X	X
Copper	X	X	
Lead	X	X	
Manganese	X	X	
Mercury	X	X	X
Methyl Mercury	X	X	
Nickel	X	X	
Selenium	X	X	
Silver	X	X	
Thallium	X		
Titanium	X	X	
Vanadium	X	X	
Zinc	X	X	X
SVOCS			
2,4-Dichlorophenol	X	X	
2,4-Dinitrotoluene	X	X	
4-Methylphenol	X	X	
Dibenzothiophene	X	X	X
Dibutyltin	X	X	
Isophorone	X	X	
M-Dichlorobenzene	X	X	
Monobutyltin	X	X	
O-Dichlorobenzene	X	X	
Petroleum Hydrocarbons	X	X	
Tributyltin	X	X	
PAHs			
1,4-Dichlorobenzene	X	X	
1-Methylnaphthalene	X	X	X
1-Methylphenanthrene	X	X	
2-Methylnaphthalene	X	X	X
2,3,5-Trimethylnaphthalen	X	X	X
2,6-Dimethylnaphthalene	X	X	X
Acenaphthylene	X	X	
Benz[a]anthracene	X	X	X
Benzo[a]pyrene	X	X	X

Table 3-2 (continued)
Lower Passaic River Restoration Project
List of Tissue COPCs Identified in PAR

Benzo[b]fluoranthene	X	X	X
Benzo[e]pyrene	X	X	X
Benzo[g,h,i]perylene	X	X	X
Benzo[k]fluoranthene	X	X	X
Biphenyl	X	X	X
Dibenz[a,h]anthracene	X		X
Indeno[1,2,3-c,d]-pyrene	X	X	X
Perylene	X	X	X
Phenanthrene	X	X	X
PCBs			
Total PCB (congeners)	X	X	X
Total PCB (aroclors)	X	X	X
PESTICIDES/HERBICIDES			
4'4-DDD	X	X	X
4'4- DDE	X	X	X
4'4-DDT	X	X	X
DDTS, total of 6 isomers	X	X	X
Total Chlordane	X	X	
DIOXINS			
2,3,7,8-TCDD	X	X	X

3.1 Data Sources

Electronic historical data have been obtained from the following sources and uploaded to the PREmis database:

- National Oceanic and Atmospheric Administration (NOAA)
- New York State Department of Environmental Conservation (NYSDEC)
- New York State Department of Health (NYSDOH)
- TAMS/EarthTech, Inc (TAMS)
- USACE
- USEPA
- TSI
- U.S. Fish and Wildlife Service (USFWS)

As of November 2003, the PREmis database contained 5,857 unique samples collected from 994 locations with the Lower Passaic River Restoration Project Study Area. These samples, which were collected from sediment, surface water, and biota, were analyzed for a variety of parameters (Table 3-3). The samples were collected during 58 relevant studies; these studies are summarized in Table 3-4.

Table 3-3
Lower Passaic River Restoration Project
Parameters Evaluated in Historical Data

GEOTECHNICAL		
% Clay	% Sand	Dry density
% Course sand	% Silt	Liquid limit
% Fine sand	% Solids	Plastic index
% Gravel	% Fines	Phi angle
% Medium sand	Wet density	Staged unconsolidated undrained triaxial
METALS / INORGANICS		
Aluminum	Cyanide	Silicon
Antimony	Iron	Silver
Arsenic	Lead	Sodium
Barium	Magnesium	Thallium
Beryllium	Manganese	Tin
Cadmium	Mercury	Titanium
Calcium	Nickel	Vanadium
Chromium	Potassium	Zinc
Cobalt	Selenium	Simultaneously extracted metals
Copper		
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)		
1,6,7-Trimethylnaphthalene	Benzo[a]pyrene	Fluorene
1-Methylnaphthalene	Benzo[b]fluoranthene	Indeno[1,2,3-c,d]-pyrene
1-Methylphenanthrene	Benzo[e]pyrene	Naphthalene
2,3,5-Trimethylnaphthalene	Benzo[g,h,i]perylene	Perylene
2,6-Dimethylnaphthalene	Benzo[k]fluoranthene	Phenanthrene
2-Methylnaphthalene	Benzoflouranthenes, total	Pyrene
Acenaphthene	Biphenyl	Low molecular weight PAHs, total
Acenaphthylene	Chrysene	High molecular weight PAHs, total
Anthracene	Dibenz[a,h]anthracene	Total PAHs
Benz[a]anthracene	Fluoranthene	
PESTICIDES		
2,4'-DDD	Chlordane	Heptachlor
2,4'-DDE	Chlordane,alpha (cis)	Heptachlor epoxide
2,4'-DDT	Chlordane,gamma (trans)	Isopropalin
4,4'-DDD	Chlordane,oxy-	Kelthane
4,4'-DDE	Dieldrin	Methoxychlor
4,4'-DDT	Diphenyl disulfide	Mirex
Aldrin	Endosulfan sulfate	Nonachlor, cis-
BHC, alpha	Endosulfan, alpha	Nonachlor, trans-
BHC, beta	Endosulfan, beta	Octachlorostyrene
BHC, delta	Endrin	Perthane
BHC, gamma	Endrin aldehyde	Total DDT
BHCs, total	Endrin ketone	Toxaphene
HERBICIDES		
2,4,5-T	Dalapon	Ddinoseb
2,4,5-TP	Dicamba	MCPA
2,4-D	Dichloroprop	MCPP
2,4-DB		
DIOXINS/FURANS		
1,2,3,4,6,7,8-HpCDD	1,2,3,7,8-PeCDF	Total HxCDD
1,2,3,4,6,7,8-HpCDF	2,3,4,6,7,8-HxCDF	Total HxCDF
1,2,3,4,7,8,9-HpCDF	2,3,4,6,7-PeCDF	Total PCDDs
1,2,3,4,7,8-HxCDD	2,3,4,7,8-PeCDF	Total PCDFs
1,2,3,4,7,8-HxCDF	2,3,6,7-TeCDF	Total PeCDD
1,2,3,6,7,8-HxCDD	2,3,7,8-TCDD	Total PeCDF
1,2,3,6,7,8-HxCDF	2,3,7,8-TCDF	Total TCDD
1,2,3,7,8,9-HxCDD	3,4,6,7-TeCDF	Total TCDF
1,2,3,7,8,9-HxCDF	Total HpCDD	Total OCDD
1,2,3,7,8-PeCDD	Total HpCDF	Total OCDF

Table 3-3 (continued)
Lower Passaic River Restoration Project
Parameters Evaluated in Historical Data

POLYCHLORINATED BIPHENYLS (PCBs)		
2-Chlorobiphenyl	2,3',5,5'-Tetrachlorobiphenyl	2,3,3',4,4',6-Hexachlorobiphenyl
3-Chlorobiphenyl	2,4,4',5-Ttetrachlorobiphenyl	2,3,3',4,5,6-Hexachlorobiphenyl
4-Chlorobiphenyl	2,4,4',6-Tetrachlorobiphenyl	2,3,3',5,5',6-Hexachlorobiphenyl
2,2'-Dichlorobiphenyl	3,3',4,4'-Ttetrachlorobiphenyl	2,3',4,4',5,5'-Hexachlorobiphenyl
2,3'-Dichlorobiphenyl	3,4,4',5-Tetrachlorobiphenyl	2,3',4,4',5',6-Hexachlorobiphenyl
2,3-Dichlorobiphenyl	2,2',3,3',4-Pentachlorobiphenyl	3,3',4,4',5,5'-Hexachlorobiphenyl
2,4'-Dichlorobiphenyl	2,2',3,3',5-Pentachlorobiphenyl	2,2',3,3',4,4',5-Heptachlorobiphenyl
2,4-Dichlorobiphenyl	2,2',3,3',6-Pentachlorobiphenyl	2,2',3,3',4,4',6-Heptachlorobiphenyl
2,5-Dichlorobiphenyl	2,2',3,4,4'-Pentachlorobiphenyl	2,2',3,3',4,5,5'-Heptachlorobiphenyl
2,6-Dichlorobiphenyl	2,2',3',4,5-Pentachlorobiphenyl	2,2',3,3',4',5,6-Heptachlorobiphenyl
3,4-Dichlorobiphenyl	2,2',3,4,5'-Pentachlorobiphenyl	2,2',3,3',4,5',6-Heptachlorobiphenyl
4,4'-Dichlorobiphenyl	2,2',3,4,6-Pentachlorobiphenyl	2,2',3,3',4,5,6'-Heptachlorobiphenyl
2,2',3-Trichlorobiphenyl	2,2',3,4',6-Pentachlorobiphenyl	2,2',3,3',4,6,6'-Heptachlorobiphenyl
2,2',4-Trichlorobiphenyl	2,2',3,5,5'-Pentachlorobiphenyl	2,2',3,3',5,5',6-Heptachlorobiphenyl
2,2',5-Trichlorobiphenyl	2,2',3,5',6-Pentachlorobiphenyl	2,2',3,3',5,6,6'-Heptachlorobiphenyl
2,2',6-Trichlorobiphenyl	2,2',3,6,6'-Pentachlorobiphenyl	2,2',3,4,4',5,5'-Heptachlorobiphenyl
2,3,3'-Trichlorobiphenyl	2,2',4,4',5-Pentachlorobiphenyl	2,2',3,4,4',5',6-Heptachlorobiphenyl
2,3,4'-Trichlorobiphenyl	2,2',4,5,5'-Pentachlorobiphenyl	2,2',3,4,4',5,6'-Heptachlorobiphenyl
2,3,4-Trichlorobiphenyl	2,3,3',4,4'-Pentachlorobiphenyl	2,2',3,4,4',6,6'-Heptachlorobiphenyl
2',3,4-Trichlorobiphenyl	2',3,3',4,5-Pentachlorobiphenyl	2,2',3,4,5,5',6-Heptachlorobiphenyl
2,3',4-Trichlorobiphenyl	2,3,3',4',5-Pentachlorobiphenyl	2,2',3,4',5,5',6-Heptachlorobiphenyl
2,3,5-Trichlorobiphenyl	2,3,3',4,6-Pentachlorobiphenyl	2,3,3',4,4',5,5'-Heptachlorobiphenyl
2',3,5-Trichlorobiphenyl	2,3,3',4',6-Pentachlorobiphenyl	2,3,3',4,4',5,6-Heptachlorobiphenyl
2,3',5-Trichlorobiphenyl	2,3,3',5,6-Pentachlorobiphenyl	2,3,3',4,4',5',6-Heptachlorobiphenyl
2,3',6-Trichlorobiphenyl	2,3,4,4',5-Pentachlorobiphenyl	2,3,3',4,5,5',6-Heptachlorobiphenyl
2,4,4'-Trichlorobiphenyl	2',3,4,4',5-Pentachlorobiphenyl	2,3,3',4',5,5',6-Heptachlorobiphenyl
2,4,5-Trichlorobiphenyl	2,3',4,4',5-Pentachlorobiphenyl	2,2',3,3',4,4',5,5'-Octachlorobiphenyl
2,4',5-Trichlorobiphenyl	2,3,4,4',6-Pentachlorobiphenyl	2,2',3,3',4,4',5,6-Octachlorobiphenyl
2,4',6-Trichlorobiphenyl	2,3',4,4',6-Pentachlorobiphenyl	2,2',3,3',4,4',5',6-Octachlorobiphenyl
3,4,4'-Trichlorobiphenyl	3,3',4,4',5-Pentachlorobiphenyl	2,2',3,3',4,4',6,6'-Octachlorobiphenyl
2,2',3,3'-Tetrachlorobiphenyl	2,3,4,5,6-Pentachlorobiphenyl	2,2',3,3',4,5,5',6'-Octachlorobiphenyl
2,2',3,4'-Tetrachlorobiphenyl	2,2',3,3',4,4'-Hexachlorobiphenyl	2,2',3,3',4,5,5',6-Octachlorobiphenyl
2,2',3,4-Tetrachlorobiphenyl	2,2',3,3',4,5'-Hexachlorobiphenyl	2,2',3,3',4,5,6,6'-Octachlorobiphenyl
2,2',3,5'-Tetrachlorobiphenyl	2,2',3,3',4,5-Hexachlorobiphenyl	2,2',3,3',4,5',6,6'-Octachlorobiphenyl
2,2',3,6'-Tetrachlorobiphenyl	2,2',3,3',4,6'-Hexachlorobiphenyl	2,2',3,3',5,5',6,6'-Octachlorobiphenyl
2,2',3,6-Tetrachlorobiphenyl	2,2',3,3',5,6'-Hexachlorobiphenyl	2,2',3,4,4',5,5',6-Octachlorobiphenyl
2,2',4,4'-Tetrachlorobiphenyl	2,2',3,3',5,6-Hexachlorobiphenyl	2,3,3',4,4',5,5',6-Octachlorobiphenyl
2,2',4,5'-Tetrachlorobiphenyl	2,2',3,3',6,6'-Hexachlorobiphenyl	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
2,2',4,5-Tetrachlorobiphenyl	2,2',3,4,4',5'-Hexachlorobiphenyl	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl
2,2',5,5'-Tetrachlorobiphenyl	2,2',3,4,4',5-Hexachlorobiphenyl	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl
2,2',5,6'-Tetrachlorobiphenyl	2,2',3,4,4',6'-Hexachlorobiphenyl	Decachlorobiphenyl
2,2',6,6'-Tetrachlorobiphenyl	2,2',3,4,5,5'-Hexachlorobiphenyl	Aroclor 1016
2,3,3',4'-Tetrachlorobiphenyl	2,2',3,4',5,5'-Hexachlorobiphenyl	Aroclor 1221
2,3,3',5'-Tetrachlorobiphenyl	2,2',3,4,5',6-Hexachlorobiphenyl	Aroclor 1232
2,3,4,4'-Tetrachlorobiphenyl	2,2',3,4',5',6-Hexachlorobiphenyl	Aroclor 1242
2,3',4,4'-Tetrachlorobiphenyl	2,2',3,4,5,6'-Hexachlorobiphenyl	Aroclor 1248
2,3',4,5-Tetrachlorobiphenyl	2,2',3,5,5',6-Hexachlorobiphenyl	Aroclor 1254
2,3',4',5-Tetrachlorobiphenyl	2,2',4,4',5,5'-Hexachlorobiphenyl	Aroclor 1260
2,3',4,6-Tetrachlorobiphenyl	2,3,3',4,4',5'-Hexachlorobiphenyl	Total PCBs
2,3,4',6-Tetrachlorobiphenyl	2,3,3',4,4',5-Hexachlorobiphenyl	
	RADIONUCLIDES	
Be-7	Pb-210	Po-210
Cs-137		

Table 3-3 (continued)
Lower Passaic River Restoration Project
Parameters Evaluated in Historical Data

SEMIVOLATILE ORGANICS		
1,2,3,4-Tetrachlorobenzene	4-Chlorophenyl phenyl ether	Di-n-butyl phthalate
1,4-Dichlorobenzene	4-Methylphenol	Di-n-octyl phthalate
Hexachlorobenzene	4-Nitroaniline	Hexachlorobutadiene
1,2,4,5-Tetrachlorobenzene	4-Nitrophenol	Hexachlorocyclopentadiene
1,2,4-Trichlorobenzene	Aniline	Hexachloroethane
2,4,5-Trichlorophenol	Azobenzene	Isophorone
2,4,6-Trichlorophenol	Benzidine	M-dichlorobenzene
2,4-Dichlorophenol	Benzo(b)thiophene	Monobutyltin
2,4-Dimethylphenol	Benzoic acid	Nitrobenzene
2,4-Dinitrophenol	Benzyl alcohol	N-nitrosodimethylamine
2,4-Dinitrotoluene	Bis(2-chloroethoxy)methane	N-nitroso-di-phenylamine
2,6-/2,7-Dimethylnaphthalene	BIS(2-chloroethyl)ether	N-nitroso-di-propylamine
2,6-Dinitrotoluene	BIS(2-chloroisopropyl)ether	O-cresol
2-Chloronaphthalene	BIS(2-ethylhexyl)phthalate	O-dichlorobenzene
2-Chlorophenol	Butyl benzyl phthalate	Pentachloroanisole
2-Nitroaniline	Carbazole	Pentachlorobenzene
2-Nitrophenol	Chlorobenzilate	Pentachloronitrobenzene
3,3'-Dichlorobenzidine	Chlorpyrifos	Phenol
3-Methylphenol/4-methylphenol	Dacthal	Pyridine
3-Nitroaniline	Dibenzofuran	Tetrabutyltin
4,6-Dinitro-o-cresol	Dibenzothiophene	Tributyltin
4-Bromophenyl phenyl ether	Dibutyltin	Trifluralin
4-Chloro-3-methylphenol	Diethyl phthalate	TPH
4-Chloroaniline	Dimethylphthalate	
VOLATILE ORGANICS		
1,1,1,2-Tetrachloroethane	Acrylonitrile	Methyl ethyl ketone
1,1,1-Trichloroethane	Allyl chloride	Methyl iodide
1,1,2,2-Tetrachloroethane	Benzene	Methyl methacrylate
1,1,2-Trichloroethane	Bromobenzene	Methylene bromide
1,1-Dichloroethane	Bromochloromethane	Methylene chloride
1,1-Dichloroethene	Bromoform	Methyl-t-butyl ether
1,1-Dichloropropene	Carbon disulfide	N-butylbenzene
1,2,3-Trichlorobenzene	Carbon tetrachloride	N-propylbenzene
1,2,3-Trichloropropane	Chlorobenzene	O-xylene
1,2,4-Trimethylbenzene	Chlorodibromomethane	P-isopropyltoluene
1,2-Dibromo-3-chloropropane	Chloroethane	Propionitrile
1,2-Dibromoethane	Chloroform	Sec-butylbenzene
1,2-Dichloroethane	Chloroprene	Styrene
1,2-Dichloroethylene	Cis-1,2-dichloroethylene	Tert-butylbenzene
1,2-Dichloropropane	Cis-1,3-dichloropropene	Tetrachloroethylene
1,3,5-Trimethylbenzene	Cis-1,4-dichloro-2-butene	Tetrahydrofuran
1,3-Dichloropropane	Dichlorobromomethane	Toluene
1,4-Dioxane	Dichlorodifluoromethane	Total BTEX
2,2-Dichloropropane	Ethyl methacrylate	Total xylenes
2-Chloroethylvinylether	Ethylbenzene	Trans-1,2-dichloroethylene
2-Chlorotoluene	Isobutyl alcohol	Trans-1,3-dichloropropene
2-Hexanone	Isopropylbenzene	Trans-1,4-dichloro-2-butene
4-Chlorotoluene	M&P-xylene	Trichloroethylene
4-Methyl-2-pentanone	Methacrylonitrile	Trichlorofluoromethane
Acetone	Methyl bromide	Vinyl acetate
Acid volatile sulfides	Methyl chloride	Vinyl chloride
Acrolein		

Table 3-4
Lower Passaic River Restoration Project
Studies Relevant to the Historical Data Evaluation

PREmis Study ID	Organization/Program	Study Name
465	NST	NOAA NS&T Hudson-Raritan Phase I, 1991
466	NST	NOAA NS&T Hudson-Raritan Phase II, 1993
471	NYSDEC	NYSDEC 1975
472	NYSDEC	NYSDEC 1980
473	NYSDEC	NYSDEC 1983
474	NYSDEC	NYSDEC 1984
475	NYSDEC	NYSDEC 1985
476	NYSDEC	NYSDEC 1987
477	NYSDEC	NYSDEC 1990
478	NYSDEC	NYSDEC 1993
479	NYSDEC	NYSDEC 1994
480	NYSDEC	NYSDEC 1995
481	NYSDEC	NYSDEC 1997
482	NYSDEC	NYSDEC 1998
483	Superfund - TAMS	TAMS Hudson River Database, HR-002
484	Superfund - TAMS	TAMS Hudson River Database, HR-003
485	Superfund – TAMS	TAMS Hudson River Database, HR-004
486	Superfund – TAMS	TAMS Hudson River Database, HR-006
462	USEPA	EPA EMAP 90-92
463	USEPA	REMAP, 1993
464	USEPA	REMAP, 1994
97	Dredged Material Testing	PASSAIC 1990 Surficial Sediment Investigation
98	Dredged Material Testing	PASSAIC 1991 Core Sediment Investigation
99	Dredged Material Testing	PASSAIC 1992 Core Sediment Investigation
100	Dredged Material Testing	PASSAIC 1993 Core Sediment Investigation - 01 (March)
104	Dredged Material Testing	PASSAIC 1993 Core Sediment Investigation - 02 (July)
106	Dredged Material Testing	PASSAIC 1993 USEPA Surficial Sediment Program
107	Dredged Material Testing	PASSAIC 1994 USEPA Surficial Sediment Program
119	Dredged Material Testing	PASSAIC 1995 Biological Sampling Program
120	Dredged Material Testing	PASSAIC 1995 RI Sampling Program
121	Dredged Material Testing	PASSAIC 1995 Sediment Grab Sampling Program
122	Dredged Material Testing	PASSAIC 1995 USACE Minish Park Investigation
144	Dredged Material Testing	PASSAIC 1996 Newark Bay Reach A Sediment Sampling Program
146	Dredged Material Testing	PASSAIC 1997 Newark Bay Reach B, C, D Sampling Program
147	Dredged Material Testing	PASSAIC 1997 Outfall Sampling Program
148	Dredged Material Testing	PASSAIC 1998 Newark Bay Elizabeth Channel Sampling Program
149	Dredged Material Testing	PASSAIC 1999/2000 Minish Park Monitoring Program
530	Superfund - Passaic	PASSAIC 1999 Late Summer/Early Fall ESP Sampling Program
531	Superfund - Passaic	PASSAIC 1999 Newark Bay Reach ABCD Baseline Sampling Program
532	Superfund - Passaic	PASSAIC 1999 Sediment Sampling Program
533	Superfund - Passaic	PASSAIC 2000 Spring ESP Sampling Program

Table 3-4 (continued)
Lower Passaic River Restoration Project
Studies Relevant to the Historical Data Evaluation

PREmis Study ID	Organization/Program	Study Name
534	Superfund - Passaic	PASSAIC 2001 Supplemental ESP Biota Sampling Program
535	Superfund - Passaic	93F62MT: MOTBY (MILITARY OCEAN TERMINAL AT BAYONNE)
536	Superfund - Passaic	93F64CL: CLAREMONT 93 REACH III (93FCLMT)
537	Superfund - Passaic	93F64HR: HACKENSACK RIVER
538	Superfund - Passaic	93F64PE: PORT ELIZABETH 93
539	Superfund - Passaic	94F36BU: BUTTERMILK
540	Superfund - Passaic	94F41HU: HUDSON_RIVER
541	Superfund - Passaic	94F62LI: LIBERTY_ISLAND
542	Superfund - Passaic	95F34BR: BAY_RIDGE
543	Superfund - Passaic	95F34RH: RED_HOOK
544	Superfund - Passaic	95F64CL: CLAREMONT_RETEST
545	Superfund - Passaic	95F64PJ: PORT_JERSEY
546	Superfund - Passaic	96PEXXON: EXXON
547	Superfund - Passaic	96PNBCDF: NEWARK BAY CONFINED DISPOSAL FACILITY
548	Superfund - Passaic	96PPANYNJ: PORT AUTHORITY NEW YORK NEW JERSEY
550	Superfund - Passaic	97F62RH: ACOE_RED_HOOK_FLATS
551	Superfund – Passaic	97F62RH_RE: COE_RED_HOOK_FLATS_RETEST

3.2 Data Quality

Prior to conducting the historical data evaluation, a data quality screening process was devised and used to determine whether or not available historical data were of sufficient quality for inclusion in the project database. A list of 45 attributes (data quality factors) that are the most useful in establishing data quality was compiled into a checklist to determine the quality of data.

Further details regarding the data quality screening process are discussed in the Technical Memorandum: Preliminary Data Quality Scheme – Passaic River Restoration Project Superfund Site (Battelle, 2004) and the Historical Data Evaluation (MPI, 2004). In summary, the data screening resulted in all 58 relevant studies being assessed as acceptable for this evaluation.

3.3 Summary of Results

This section summarizes the major findings of the Historical Data Evaluation for the following classes of chemicals. A list of the parameters selected as benchmark chemicals is included in Table 3-5. It should be noted that an evaluation has not yet been conducted for conventional parameters, radionuclides, and TPH. The primary categories of selected benchmark chemicals include:

- Metals
- Pesticides/Herbicides
- Volatile Organic Carbons (VOCs)
- Semi-Volatile Organic Carbons (SVOCs)
- PCBs
- Dioxins/Furans

For each chemical class, Table 3-6 summarizes the number of surface and subsurface sediment samples included in the historical data evaluation, the SQGs used, and the benchmark chemicals selected. Refer to Figures 3-1 through 3-34, which illustrate the spatial distribution of benchmark chemicals in the sediment. Refer to Tables 3-7 and 3-8 for summaries of the benchmark chemicals.

Table 3-5
Lower Passaic River Restoration Project
Chemicals Identified as Benchmark Chemicals

Benchmark Chemical	Surface Sediment Area of Contamination	Location of Maximum Surface Concentration	Location of Maximum Subsurface Concentration
METALS			
Lead	RMs 2.0-4.0 (Harrison Reach) and 6.0-7.0 (Kearny Reach)	RM 17 (Upstream Reach)	Intersection of the Harrison and Newark Reaches at a depth of 6ft
Mercury	RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	RM 8.7 (Upstream Reach)	Harrison Reach at a depth of approximately 12ft
Silver	RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	Upstream Reach	Harrison Reach at a depth of approximately 12ft
Cobalt	RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	Harrison Reach	Point No Point Reach at a depth of approximately 2.5ft
Zinc	RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	Upstream Reach	Point No Point Reach at a depth of approximately 4.5ft
PESTICIDES/HERBICIDES			
DDT	RMs 2.0-4.0 (Harrison Reach) and 6.0-7.0 (Newark and Kearny Reaches)	Harrison Reach	Intersection of the Newark and Kearny Reaches (RMs 6.0-7.0) at a depth of 3-5ft
Chlordane	RMs 2.0-4.0 (Harrison Reach)	Kearny Reach	RM 1.0-2.7 (Point No Point and Harrison Reach) at a depth of 2.5-3.5ft
Dieldrin	RMs 2.0-4.5 (Harrison Reach)	RM 1.1 (No Point Reach)	RM 3.2 (Harrison Reach) at a depth of 3.5-4.5ft
Mirex	RMs 2.0-4.0 (Harrison Reach)	RM 2.1 (Harrison Reach)	Intersection of Third River and Passaic River
VOCs			
Xylenes	RMs 0.0-6.5 (Point No Point, Harrison, Newark, and Kearny Reaches)	RM 1.2 (No Point Reach)	Between RMs 2.85-4.4 (Harrison Reach) at a depth of 3-6ft

Table 3-5 (continued)
Lower Passaic River Restoration Project
Chemicals Identified as Benchmark Chemicals

Methyl ethyl ketone	RMs 1.0-6.5 (Point No Point, Harrison, Newark, and Kearny Reaches)		Between RMs 3.15-3.25 (Harrison Reach) at a depth of 3-6ft
SVOCs			
HMW PAHs	Between RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	RM 4.5 (Harrison Reach)	RM 3.0 (Harrison Reach) at a depth of 1-3ft and at RM 4.0 (Harrison Reach) at a depth of 3-6ft
LMW PAHs	RMs 0.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	RM 4.5 (Harrison Reach)	RM 3.0 at a depth of 1-3ft and at RM 4.0 at a depth of 3-6ft
PCBs			
PCBs	RMs 1.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches)	Kearny Reach	RMs 1.0-7.0 (Point No Point, Harrison, Newark, and Kearny Reaches) at a depth of 6 ft
DIOXINS/FURANS			
2,3,7,8 TCDD and Dioxin/Furan TEQ	RMs 2.5-4.5 (Harrison Reach)	Harrison Reach	Harrison Reach, 2 highest sample concentrations were near RM 3.0 at a depth of 3-6ft

Table 3-6
Lower Passaic River Restoration Project
Summary of Samples, Sediment Quality Guidelines, and Benchmark Chemicals Selected

Chemical Class	Number of Samples		Sediment Quality Guidelines Used	Benchmark Chemicals Selected
	Surficial	Subsurface		
Metals	378	643	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M	Lead; mercury; silver; cobalt; zinc.
Pesticides/ Herbicides	261	626	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M, ER-L.	Total DDT; total chlordane; dieldrin; mirex.
VOCs	142	537	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M, ER-L were not available. Therefore, the most conservative screening values for all other screening guidelines were used (1).	Total xylenes; methyl ethyl ketone.
SVOCs	244 (330 for PAHs)	622 (611 for PAHs)	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M, ER-L were not available for SVOCs. Therefore, the most conservative screening values for all other screening guidelines were used for all other SVOCs (1). For PAHs, the 1997 NOAA Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments, ER-M values, were used.	High Molecular Weight PAHs; Low Molecular Weight PAHs.
PCBs	255	580	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M	Total PCBs.
Dioxins/ Furans	267	598	1998 NJDEP Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) ER-M, ER-L were not available. Therefore, a 1 ng TEQ/g (TEQ = Toxic Equivalency Quotient) screening value was used as published by the World Health Organization (1997).	2,3,7,8-TCDD; dioxin TEQ.

(1): These screening criteria include:

- National Ambient Water Quality Criteria: 1997 Sediment Quality Benchmarks, Marine/Estuarine - NAWQC Chronic Values.
- National Ambient Water Quality Criteria: 1997 Sediment Quality Benchmarks, Marine/Estuarine - NAWQC Secondary Chronic Values.
- USEPA Office of Solid Waste and Emergency Response Ecotox Thresholds. As cited in Jones et al., 1997.
- USEPA Region 5, RCRA Ecological Screening Levels, 2003.
- National Oceanographic and Atmospheric Administration: Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments, ER-M Values, 1997.

Table 3-7
Lower Passaic River Restoration Project
Statistical Report for Benchmark Chemicals in Surface Sediment

Chemical	Min. Conc.	Max. Conc.	Avg. Conc.	Detection Frequency	SQG Conc.	Exceedance Frequency	Units
Lead	< 0.01	2200	225	337 / 344	218	225 / 344	ppm
Mercury	< 0.01	12.4	3.0	261 / 344	0.71	242 / 344	ppm
Silver	< 0.01	39.5	4.5	227 / 341	3.7	127 / 341	ppm
Cobalt	< 0.01	41.1	8.9	299 / 321	NA[1]	NA	ppm
Zinc	< 0.01	1900	425	332 / 344	410	213 / 344	ppm
Total DDT	6.0	5980	231	238 / 261	46	216/261	ppb
Total Chlordane	3.0	210	49	130 / 232	7.0	125/232	ppb
Dieldrin	4.0	270	27	119 / 261	2.0	119/261	ppb
Mirex	9.0	135	26	12 / 13	7.0	12/13	ppb
Total Xylenes	2.0	440	108	13 / 142	25	9 / 142	ppb
Methyl Ethyl Ketone	9.0	83	36	29 / 142	43	9 / 142	ppb
HMW PAHs (total)	1,500	1,400,000	30,062	326 / 330	9,600	288 / 330	ppb
LMW PAHs (total)	210	1,410,000	10,603	299 / 330	3,160	158 / 330	ppb
Total PCBs	200	7,640	1,416	221 / 255	180	212 / 255	ppb
2,3,7,8-TCDD	34	6,200	518	260 / 266	NA	NA	ppt

1 – None Available

Table 3-8
Lower Passaic River Restoration Project
Statistical Report for Benchmark Chemicals in Subsurface Sediment

Chemical	Min. Conc.	Max. Conc.	Avg. Conc.	Detection Frequency	SQG Conc.	Exceedance Frequency	Units
Lead	1.0	22,000	527	573 / 619	218	443 / 619	ppm
Mercury	0.01	29.6	7.7	511 / 618	0.71	472 / 618	ppm
Silver	0.63	26.7	9.1	413 / 616	3.7	363 / 616	ppm
Cobalt	2.6	42.9	12.8	570 / 616	NA[1]	NA	ppm
Zinc	10.8	3,110	789	592 / 619	410	432 / 619	ppm
Total DDT	4.1	18,600,000[2]	61,250	471 / 606	46	417 / 606	ppb
Total Chlordane	3.0	791	72	328 / 578	7.0	311 / 578	ppb
Dieldrin	2.0	580	63	313 / 615	2.0	312 / 615	ppb
Mirex	No subsurface samples						
Total Xylenes	3.0	150,000	1,130	233 / 526	25	216 / 526	ppb
Methyl Ethyl Ketone	10.0	7,200	109	315 / 526	43	196 / 526	ppb
HMW PAHs (total)	220	2,290,000	43,500	517 / 611	9,600	451 / 611	ppb
LMW PAHs (total)	280	5,460,000	39,700	474 / 610	3,160	322 / 610	ppb
Total PCBs	180	27,560	2,774	351 / 580	Not calculated	Not calculated	ppb
2,3,7,8-TCDD	0.8	1,087,000	10,596	524 / 598	NA	NA	ppt

1 – None Available
2 – It should be noted that this sample concentration is anomalous when compared to all of the other DDT sample results. Therefore, it is possible that this value is unreliable.

3.4 Data Gaps

During the surface sediment data evaluation process, the following data gaps were identified:

- There has been no comparison of historical and current bathymetric data to identify how the bottom of the river has changed over time.
- Data is needed regarding loads coming in from tributaries, point sources, and the Passaic River above Dundee Dam.
- The majority of the historical samples were collected from the Harrison Reach. Additional sampling will be needed from the upper reaches.
- The vertical extent of contamination is not well defined.
- There is very little data for methylmercury concentrations in the river.
- There are very few historical surface water samples collected for the Lower Passaic River Study Area.

- There is very little historical PCB congener data available.

These data gaps were considered in the development of DQOs (refer to Section X of the QAPP for further information).

4.0 WORK PLAN RATIONALE

The Passaic River has an approximate 200 year history of industrialization. The River has been the receiving water body for industrial waste from petroleum refining, tanneries wood preserving, metal working and production facilities manufacturing rubber, textiles, paints, dyes, pharmaceuticals chemicals, leather and paper products.

Although environmental investigations have been conducted at specific areas on the Passaic River in the past, there has been no comprehensive program to assess the overall environmental conditions of the River. Phase 2 of this RI/FS program is designed to address this need. This Work Plan outlines the proposed investigation effort for Phase 2. The program is designed to provide data to answer the following questions:

- If we take no action on the River, when will the COPCs recover to acceptable concentrations?
- Can any action we take on the River significantly shorten the time required to achieve acceptable or interim risk-based concentrations for human receptors and ecological receptors?
- Are there contaminated sediments now buried that are likely to become "reactivated" following a major flood, possibly resulting in an increase in contaminants of the fish/crab populations?
- Can any action we take on the River or adjacent areas significantly improve the functionality of ecosystems within the Lower Passaic River watershed?
- If the risk assessment for Newark Bay demonstrates unacceptable risks due to export of contaminants from the Passaic River, will the plan proposed to achieve acceptable risks for Passaic River receptors significantly shorten the time required to achieve acceptable or interim risk-based concentrations for human and ecological receptors in Newark Bay, or will additional actions be required on the Passaic River?

In addition, copies of the Conceptual Site Models (CSM) from the Draft PAR (Battelle 2004) are attached as Figures 4-1 and 4-2.

5.0 FIELD INVESTIGATION TASKS

5.1 Overview

This section summarizes the field investigation tasks required to support the RI/FS for the site. More detailed information regarding the field tasks can be found in the Lower Passaic River FSP. Additional information regarding quality assurance/quality control (QA/QC) for these sampling events can be found in the Quality Assurance Project Plan (QAPP).

5.2 Bathymetric and Geophysical Surveys

5.2.1 Base Maps (Bathymetric, aerial, and Supplemental Land Surveys

Bathymetric data and shoreline mapping for the Lower Passaic River are required for the 17-mile river stretch from Newark Bay to the Dundee Dam to support the following data needs:

- Evaluate the river's configuration and geomorphology and compare to historical data.
- Develop hydraulic analyses, which will aid in the design of the re-grading plan.
- Identify potential sediment scour/deposition areas in the Passaic River.
- Support FS feasibility analyses and dredging alternative evaluations.
- Determine the elevation and topography of candidate sites to support restoration design.
- Determine the grades of the side slopes of the Passaic River and tributaries to support design of bank stabilization/re-grading measures that may be necessary during restoration.
- Determine site access and location of utilities and other objects.

The objectives of the bathymetric and aerial surveys are to obtain recent, detailed geographic data and develop mapping of the Passaic River bathymetry and shoreline to address these data needs. It is anticipated that bathymetric data will be collected on transects that are spaced every 100 feet with soundings every 10-15 feet along each transect. To survey outside the channel of the Passaic River and upland adjacent areas, Digital Ortho Photography (aerials) will be obtained. The photography will be collected with enough accuracy to produce 0.5-foot contours on one inch equals thirty feet (1″ =

30′) scaled maps. The land survey objectives are to obtain data, develop mapping, and understand constraints for portions of candidate restoration sites not already addressed by existing data and the bathymetry/aerial surveys.

5.2.2 Geophysical Surveying

The purpose of the geophysical survey is to aid in the interpolation between sediment core sampling locations to reduce uncertainty regarding sediment texture and profile, and potentially, contaminant concentrations, to support engineering decisions required for the FS. The objectives for the geophysical surveys include:

- Determine the texture of the surficial sediment to understand the characteristics of the Passaic River bottom.
- Determine the amount/extent of debris and other targets (*e.g.*, utilities, wrecks) in the Lower Passaic River to evaluate the feasibility of remedial dredging and achieving restoration objectives at a particular site.
- Determine the significant geological layers of the sediment to support investigations and engineering analyses.

The geophysical survey will consist primarily of a side-scan sonar survey to characterize and map sediment texture in the Passaic River. Supplemental tasks could include sub-bottom profiling, and will be implemented based on the results of the geophysical prove-out surveys. Side-scan sonar provides mosaic images of the investigation area while sub-bottom profiling investigates sediment stratigraphy and refines the geologic framework between coring locations. Acoustical techniques and potentially ground penetrating radar, supplemented by sampling, will be used to derive interpretive diagrams of the river bed, and to identify sediment characteristics of the river bed and active sedimentation processes. Confirmatory shallow sediment core and deep sediment core sampling of river bottom sediments will be conducted to calibrate and verify the results of the geophysical investigation.

5.3 Sediment Investigations

Several different types of sediment samples will be collected during the Lower Passaic River Restoration Project RI/FS. Each type of sample is described below.

5.3.1 High Resolution Sediment Coring

The high resolution sediment core program will examine long term trends in COPC transport and fate via an examination of the sediment record throughout the Study Area. The specific issues to be addressed in this study include:

- Recent trends in COPC levels in sediments and, by implication, recent trends in mean annual water column COPC levels
- Nature and extent of current sources of COPCs to the Lower Passaic River
- Nature and extent of historic input of COPCs to the Lower Passaic River
- Rate of in situ degradation in the Lower Passaic River sediments
- Anticipated residence time for COPCs in the sediments
- Geochemical processes affecting sediment COPC levels, also, fate, transport and bioavailability
- Burial rate and age progression with depth of sediment using long-lived radionuclides
- Depth of the mixing zone using short-lived radionuclides

The high resolution sediment cores will be collected from areas of relatively continuous fine-grained sediment material and the cores will be sectioned into highly resolved sections (*i.e.,* approximately two to four centimeters each) to provide detailed history of contaminant deposition. The cores collected for this program will be interpreted as records of water-borne COPC transport.

5.3.2 Bioturbation Survey

The results of the high resolution coring program will be utilized to gain an understanding of the net effect of bioturbation. Bioturbation is the random vertical mixing of surficial sediment due to benthic organisms. This mixing process homogenizes sediments and facilitates the interactions between porewater and the overlying surface water. In general, individual bioturbation processes are difficult to model because of the physiological differences in benthic organisms and their lifestyles (*e.g.*, worms form tunnels, bivalves flush water, crabs burrow). Hence, all these mixing processes are grouped into one random, bioturbation-mixing process and expressed as a vertical mixing rate (cm/yr).

Vertical mixing of the sediments can also be achieved by tidal flows, storms, wave action, boat traffic and other non-biological processes. These processes have the same net effect as bioturbation, that is, to mix the uppermost layers of the sediment. The effects of these physical processes cannot be easily discerned from those due to biota. The net effect of the various processes is essentially the same and so they can be treated as a single net vertical mixing rate (apparent bioturbation rate).

Disequilibrium of radioisotopes in sediments and porewaters compounded with a vertical mixing model are used to estimate the apparent bioturbation rates. Radioactive disequilibrium in this instance refers to the condition of having a higher concentration of daughter products than can be sustained by the decay of the parent isotopes present. Examples of radioisotopes that can measure bioturbation rates in the Lower Passaic River are lead-210, beryllium-7, and thorium-234. Excess radioisotopes are present in surficial sediment due to scavenging from sea water. If the rate of deposition is greater than the rate of radioactive decay, then a sediment profile of radioactivity will show the depth of vertical mixing due to bioturbation and provide an approximate deposition rate. Beryllium-7 activity and thorium-234 activity can be measured in dry sediment from a core with a gamma spectrometer while lead-210 activity can be measured with an alpha spectrometer.

5.3.3 Low Resolution Sediment Coring

A low resolution sediment coring investigation will be conducted for the Lower Passaic River Restoration Project study area. The objectives for the low resolution sediment coring program include:

- Delineate the horizontal and vertical concentrations of sediment COPCs within the Study Area
- Identify previously unknown or poorly documented areas of sediment COPC contamination, especially in the upper 11 miles of the Study Area where little or no historical sampling has occurred
- Determine the physical properties of the sediments within the Study Area

Low resolution coring program sediment samples will be collected using one or a combination of the following techniques: vibracoring, push coring and piston coring, as necessary to obtain adequate recovery and retrieve representative sediment samples. The type of coring technique used will initially be selected based on the physical characteristics of the study area. This may be field-corrected based on actual conditions encountered.

The low resolution sediment cores will be divided into sections approximately six inches in length and the applicable sections will be analyzed for a variety of chemical and physical parameters. The core locations, spacing, and target depth are to be determined.

5.3.4 Sediment Transport Investigation

Sediment dynamics inherent in the model that will be developed for the site (Refer to Section 7) will include sediment resuspension, sediment transport, and deposition of both cohesive and non-cohesive sediments. The primary site characteristics that affect sediment stability are the shear stress at the river bottom under varying conditions, the physical properties of the upper sediment layers, and bioturbation. Bioturbation is discussed in Section 5.3.3.

Sediment deposits can change significantly in spatial extent (both horizontally and vertically) and can be easily resuspended and redeposited by storms and other river hydraulic altering events (*e.g.,* , dredging). For the long-term prediction of both sediment and contaminant transport, one of the most significant processes to understand and quantify is the sediment erosion rate. These rates can change by orders of magnitude, not only as a function of the applied shear stress due to waves and currents but also as a function of horizontal location and depth in the sediment. To model the Lower Passaic River Tidal system, the sediment transport investigation will consider erosion, resuspension and deposition processes by conducting special sediment studies. These studies will include:

- Collect sediment cores and submit samples for bulk sediment properties such as bulk density or water content, median particle size and organic content (Roberts, *et al.*, 1998).
- Collect sediment cores and submit samples for radionuclide analysis to characterize recent sediment deposition.
- Conduct Gust Microcosm field experiments to test for changes in surficial sediment erodibility over the range of 0-0.4 Pa applied shear stress. This erosion testing and its protocols, which involve increasing shear stress through approximately 8 levels, with each level of constant stress lasting approximately 20 minutes, is described in detail in Sanford and Maa (2001).

- Conduct Modified Valeport Settling Tube experiment (Owen-type bottom withdrawal settling tube) on water column TSS samples to determine settling velocity following protocols described in Sanford *et al*. (2001).
- Conduct Particle Entrainment Simulator (PES) experiments on sediment cores to determine erosion resistance with time, following sediment disturbance. This will involve production of a sediment-water slurry using Passaic River water and the field collected sediment samples, which will be allowed to consolidate for periods of 1, 4, and 7 days before erosion testing.
- Conduct Sedflume experiments on sediment cores to determine erosion rates as a function of depth and shear stress. Sedflume measures in-situ sediment erosion and transport properties at shear stresses ranging from normal flow to flood conditions and with depth below the sediment/water interface. Protocols for conducting at SedFlume experiments are described in McNeil *et al*. (1996).

5.3.5 Sediment Sampling in Mudflats

Sediment sampling within exposed mudflats within the Study Area will be conducted to determine the potential for adverse human health and ecological effects. Unlike river sediments, mudflats are periodically exposed to varying degrees over the tidal cycle and therefore, could potentially provide a higher potential for receptor exposure e.g. wading birds, shore birds, water fowl, mammals) to environmental contaminants via dermal contact and inadvertent ingestion.

Sediment samples will be collected using manual techniques (e.g. grab sampler, piston corer) from the surface to a maximum depth of 12 inches, which will encompass the majority of the biologically active zone (BAZ). These samples will be analyzed for a variety of parameters that could include, but are not limited to: COPCs, biochemical oxygen demand (BOD), pH, total organic carbon (TOC), Total Kjeldahl Nitrogen (TKN), phosphorus, and nutrients.

5.4 Hydrologic and Water Quality Investigations

Several different types of water samples will be collected during the Lower Passaic River Restoration Project RI/FS. Each type of sample is described below.

5.4.1 Hydrodynamic and Suspended Sediment Investigations

One of the primary objectives for the Lower Passaic River RI/FS is to develop and apply a scientifically-based model that incorporates hydrodynamic transport, sediment transport, contaminant fate and transport and bioaccumulation processes. This

Lower Passaic River Model will be used as a tool for understanding historical and current sources and sinks of organic and inorganic contaminants in the Study Area and adjacent water bodies through mass balance analyses, as well as provide the basis for an engineering evaluation of potential remedial scenarios. The goals of the hydrodynamic investigation are (1) to provide the baseline data set within the Study Area for calibrating and assessing the skill of the hydrodynamic components of the proposed Lower Passaic River Model and (2) to characterize the aspects of the circulation and dispersive nature of the Lower Passaic River and describe how these processes change with tidal range and river discharge.

The activities that will be undertaken during this investigation include:

- Continuous monitoring using moored instrumentation installed at fixed stations within each reach of the Lower Passaic River, which will result in fixed-point time series of a variety of model calibration and evaluation data, including current velocities and directions, salinity, and temperature.
- Shipboard CTD (Conductivity, temperature and depth) under varying tidal and flow conditions. The data collected during the shipboard surveys will supplement the data obtained from the moorings, and will help characterize the strength of the tidal, two-layer flow in the Lower Passaic River by delineating the location of the salt wedge and stratification as a function of river flow.
- Cross-Section ship-track surveys to provide information on cross-channel circulation, especially along river bends. These will also provide water quality cross-sectional distribution data that will be useful in assessing the model's capability to simulate observed vertical and cross-channel shears in the flow. Assessment of the model's capability to adequately simulate vertical and cross-channel shears in flow is critical since vertical and horizontal shears drive dispersion in a tidal riverine system.
- Dye studies, consisting of the release of an inert tracer up-estuary of the Study Area (above the Dundee Dam), and then measuring its concentration profile to characterize the short hour time-scale dispersive nature of the Lower Passaic River. The quantification and characterization of dispersion and mixing rates in the Lower Passaic River through this dye study will provide an important and extremely relevant dataset to test the hydrodynamic component of the Lower Passaic River Model's skill, by testing the model simulation against the evolving structure of the passive dye tracer.
- TSS sampling to gain an understanding of the transport of fine-grained sediments in order to be able to predict contaminant fluxes (since most COPCs will be adsorbed onto the particulates). In the Lower Passaic River, there are various processes that cause total suspended sediment (TSS) concentration to vary over time including: turbulence, semidiurnal tides, diurnal tides, other tidal harmonics, lower frequency tidal cycles, wind waves, watershed inflow, and climatic variability.

- TSS sampling to identify the estuarine turbidity maximum (ETM) zone, which is a region where the concentration of TSS may be a hundred times greater than concentrations both seaward and landward.
- Sampling for naturally occurring radionuclides to determine the processes controlling the short-term fate and transport of particles within the estuary, especially at the ETM.

5.4.2 CSO Sampling

Combined sewers transport treated or untreated sanitary and industrial wastewater during dry weather conditions and combined wastewater and stormwater runoff during wet weather conditions. Typically, these waters are sent to municipal treatment facilities, *i.e.,* publicly owned treatment works (POTWs). However, when the capacity of the POTW is exceeded, untreated excess wastewater that cannot be treated at the POTWs is typically diverted via regulatory chambers directly to the receiving water body(ies). The regulatory chambers are usually located where local sewerage districts join the CSO trunkline. In these cases, CSO effluent can contribute substantially to total chemical loading in a riverine system (EPA, 1994; EPA, 1980).

Details of the CSOs down-estuary of the Dundee Dam, including CSO name, location and receiving water body are provided in Table 2 and Figures 1-4 and 1-5. The CSO sampling program will involve collection of wastewater and settleable solid samples from CSOs that discharge into the Lower Passaic River. The samples will be analyzed for COPCs to provide information regarding the loads of COPC discharged to the Lower Passaic River from CSOs. The estimated COPC load contributions from CSOs to the Lower Passaic River will be used for:

- inputs of COPCs in the Passaic River modeling framework.
- analyzing fate and transport of COPC in the remedial investigation.
- evaluating the effectiveness of remedial alternatives in the Feasibility Study (FS).

The CSO samples will be collected during storm events. The number of seasonal CSO sampling surveys to be conducted is to be determined.

5.4.3 Float Survey and Other Screening Level Investigations

Sampling of the water column via a float survey along the seventeen-mile Lower Passaic River will enhance the current understanding of the locations of contaminated sediment deposits and point source discharges of contaminants and their impacts on the surface water quality of the Passaic River. The Float Survey is intended to function as a screening investigation to identify locations of concern, and in that regard, may be supplemented by other sediment screening level surveys including "Underway Surficial Sediment Sampling" and collection of sediment cores for bioassay and XRF screening analyses. Underway Surficial Sediment Sampling (USGS, 2001) is conducted via a survey vessel that tows a sampling intake along the sediment/water interface, disturbing the upper few inches of sediment, which are then captured by a sampling pump and transferred to an on-board gas chromatograph for screening level analysis. The towed sled investigation generates a continuous, screening level profile of sediment contaminant concentrations along the vessel survey lines.

The float survey will be conducted using three sampling boats, with one boat floating in the center channel of the river, traveling with the pace of downstream flow and tidal transport, and two additional boats keeping pace with the center boat along the east and west shoals of the river. Although the shoal boats will not be sampling the exact parcel of water sampled by the center channel boat, it is assumed that conditions are relatively steady state, and the sampling effort allows the evaluation of the instantaneous load over the river cross-section, the contaminant concentration gradient across the river cross-section, and the changes in the load between sampling points. Sampling frequency will be dependent on the characteristics of the river, including the location of tributaries, CSOs, and point source discharges, but will likely entail collection of a depth-integrated water column sample from each boat approximately every 0.25 miles of travel.

The float survey, which may include multiple, seasonal sampling efforts, is expected to help distinguish point sources from existing contaminated sediment areas and characterize the distribution of contaminated sediment throughout the river and within the river's cross-section (*i.e.*, channel vs. shoals). By analyzing water column samples for a comprehensive suite of environmental contaminants, sediment areas of concern and their corresponding pollutants can be delineated. Consideration of the identity of detected water column contaminants may help to evaluate whether they stem from point sources or neighboring sediment areas.

Several environmental gradients along the Lower Passaic River will be modeled with combined data from the float survey and from other hydrologic characterization and modeling activities (*e.g.*, water quality monitoring from installed moorings) associated with this work plan. Additional monitoring data may be required from the shoal areas (*e.g.*, salinity) to model the contaminant migration due to tidal influence and mixing. Finally, data obtained from the float survey will be used to determine the locations of future sediment cores to further characterize the nature and extent of sediment contamination.

5.4.4 Tributary and Water Body Sampling

There are many neighboring water body and tributary influences to the Lower Passaic River (*i.e.,* the Hackensack River, Third River, Second River, Franks Creek, Lawyers Creek, Berry's Creek, Pierson Creek, Newark Bay, and the Arthur Kill and Kill van Kull). Understanding the influence these water bodies have on the hydraulic properties and contaminant profile of the Lower Passaic River is necessary for modeling purposes and assessing the success of selected remedial actions. The sampling program will entail discharge and water column samples for COPCs, TSS, POC, DOC, and other general water quality parameters (*e.g.,* pH, salinity, chlorophyll-a, coliform, DO). Discrete samples will also be collected to determine the dissolved and particulate phases of contaminants.

Furthermore, rating curves have been developed through the CARP program for suspended sediment loads and sediment loads of various COPCs from some tributaries that influence the Passaic River and adjacent waterbodies. To the extent that these rating curves are applicable, the data will be used to estimate loads of COPCs. Additional data will be collected to develop similar curves for tributaries that were not sampled by CARP program, as well as for upstream boundary COPC and TSS loads transported over the Dundee Dam. Sampling in these tributaries will be done at the boundary of the model domain.

USEPA and other agencies are conducting or planning to conduct similar sampling programs within some of these water body influences (*i.e.,* Berry's Creek, Newark Bay). Activities within this work plan and activities underway within the other water body influences will be shared across agencies and coordinated so that sampling and data overlap is prevented.

5.4.5 Monitoring Stations – Storm Events

Surface water column monitoring stations will be established in the Lower Passaic River, its tributaries, and other adjacent water bodies (*e.g.*, Hackensack River) to collect data for the modeling and FS tasks. The locations of these stations will be determined based on an investigation that will identify high probability storm water runoff areas. Strategic water column sampling will occur at these stations during storm events[6] to determine the runoff coefficient and added loadings that are brought on by higher flows, erosion, and scouring.

Both grab and composite samples[7] will be collected through manual and automated techniques for analysis of a variety of parameters including, but not limited to, pH, organic and inorganic contaminants, water quality parameters, suspended sediment concentrations, suspended sediment chemical and physical parameters, nutrients, organic carbon, pathogens, nitrates, and sulfides. The sampling technique (*i.e.*, manual vs. automated and grab vs. composite) will be dependant on the types of parameters to be analyzed.

Automatic samplers consist of a continuously recording flow meter linked to an automatic water sampler, which draws a composite sample from the stream when the flow meter indicates that desired flow conditions exist (*e.g.*, rising stream due to stormwater runoff). The equipment will be programmed to collect samples on either time-paced (*e.g.,* one sample every 15 minutes), or flow-paced (*e.g.*, one sample every 100 cubic feet) intervals. The instrumentation will be programmed to collect water samples representing various hydrologic conditions (*i.e.,* baseflow, runoff, or a combination of the two). The collected data will be used to derive sediment and chemical transport models specific to the Lower Passaic River.

5.5 Sediment Porewater Sampling

Pore water, defined as the water that occupies the spaces between sediment particles, can be isolated from the sediment matrix to conduct toxicity testing or to

6 A storm event is defined by a rainfall with greater than 0.1 inch accumulation that was preceded by at least a 72-hour dry period (USEPA, 1992; EPA833-8-92-001).
7 A grab sample is considered a discrete sample collected for less than 15 minutes while a composite sample is a mix of discrete samples collected over the duration of the storm (USEPA, 1992; EPA833-8-92-001).

measure the concentration of COPCs. The objective of the sediment porewater investigation is to provide information on the bioavailability of chemicals in sediments and the potential effects of contaminated sediment on infaunal species (*i.e.*, species that utilize habitats within the sediment matrix). The porewater investigation will also aid in understanding the partitioning process occurring with the classes of COPCs. Understanding partitioning of contaminants will also provide information on the bioavailability of contaminants in the sediment. Such information is important in modeling sediment contaminant interactions and in completing the RI/FS. The data collected in this study will be used to (1) determine the relationship between porewater and bulk sediment chemical concentrations and (2) understand the transport of COPCs to the water column through chemical partitioning, diffusion, bioturbation, or resuspension processes.

Porewater sampling will be performed at locations where the sediment types range from sandy to uncompacted silt-clays since these sediment types have the highest potential interstitial water contamination. Areas with coarser particles or compacted clays will not be sampled (Sarda and Burton, 1995; SETAC, 2001). The two major issues of concern regarding porewater sample integrity are: 1) the ability of the sampling device to maintain physicochemical conditions in the natural state by minimizing adsorption/leaching of chemicals to/from the device, and 2) the ability to maintain the sample in the existing redox state found at the site. Therefore, the aim of this sampling will be to utilize procedures that minimize changes to the in-situ condition of the water.

Porewater samples will be collected using in-situ methods such as "peepers" or dialysis cells for small volume samples and ex-situ methods such as centrifugation if larger volumes are required. The number of samples to be collected and sampling locations are to be determined.

5.6 Groundwater Investigations

5.7 Atmospheric Deposition Monitoring

5.8 Biota and Ecological Risk Sampling

Based on the data needs identified in the PAR, biota sampling will be conducted for the Study Area, as described below. The objectives for this investigation are to

- Support the food web modeling for the ecological risk assessment by either field verifying bioaccumulation model results or providing actual whole body tissue concentrations of relevant prey species for inclusion in risk models.
- Support the ecological risk assessment by providing quantitative measure of the health and diversity of the aquatic community.
- Support the human health risk assessment by either field verifying bioaccumulation model results or providing actual edible tissue concentrations for selected fish and shellfish species for inclusion in risk models.

5.8.1 Benthos Sampling

Surface sediment grabs will be collected from selected locations throughout the study area using one or a combination of the following techniques; Van Veen grab sampler, ponar grab sampler, shipek, or box corer. Sediment samples will be sieved and a quantitative analysis of the benthic invertebrate community determined. The objective of this analysis will be to assess potential impacts of contaminants on the diversity and abundance of benthic macroinvertebrate species. Based on the enumeration of species present in each replicate sample, species richness and abundance can be determined for each location using a variety of diversity indices (dominance, diversity richness, eveness). The results of this evaluation will provide a measure of the health of the benthic community and the potential population level impacts of sediment-associated contaminants..

5.8.2 Fish and Shellfish Sampling

Based on the information presented in the PAR, representative species of forage fish, sport fish, and shellfish will be collected from throughout the study area for the purpose of quantifying tissue concentrations of COPCs for use in the human health and ecological risk assessment dose models. In addition, these data will provide qualitative information regarding the abundance and diversity of fish and shellfish species throughout the study area to evaluate population and community structure. Fish and shellfish collection techniques will be determined based on the target species and size class desired but may include gill nets, trawl nets, traps, beach seines, and hook and line techniques.

For the human health assessment, edible tissue (*e.g.*, fillet) concentrations of selected sport fish and shellfish will be collected and evaluated for identified chemicals of concern. The specific species evaluated will be determined based on consideration of species most likely to be targeted by recreational anglers. These data will be used to quantify risks associated with consumption of fish, and to verify the results of bioaccumulation modeling.

For the ecological assessment, whole body concentrations of forage fish and other relevant fish and shellfish species will be required to either quantify the dose modeling or validate the results of the bioaccumulation model. The specific species to be targeted for evaluation will be representative of the prey species preferred by the final receptors of concern. In addition, whole body concentrations will be evaluated with respect to body burden concentrations reported to be associated with adverse effects on behavior, growth, reproduction, and survival for those chemicals for which data are available.

5.8.3 Bioassay Sediment Sampling

Based on the information provided in the PAR, laboratory bioassay testing is anticipated as part of the investigation being conducted for the Lower Passaic River Restoration Project. The objectives for the bioassay testing program may include:

- Support the ecological risk assessment outlined in the PAR in assessing effects to benthic invertebrates from exposure to chemicals of potential ecological concern (COPECs)
- Establish a dose-response relationship between sediment COPEC concentrations and observed effects in benthic invertebrate receptors
- Determine the transfer of sediment contaminants to benthic invertebrates (*i.e.*, bioaccumulation) to support the food-wed modeling and dose assessment for higher trophic level organisms identified as receptors of concern

Bioassay sediment samples will be collected using one or a combination of the following techniques; Van Veen grab sampler, ponar grab sampler, shipek, box corer, vibratory core sampler, or push corer to obtain adequate recovery and retrieve representative sediment samples. The type of sampling technique used will be selected based on the number and type of bioassay tests to be conducted and the complexity of the test design to ensure an efficient method of sampling to achieve the test volumes required. The method will also be influenced by the physical characteristics of the sediments and depth of sample required for the test.

Typically, bioassay tests are conducted on surface sediments representing the BAZ; generally the top 5 centimeters of sediment (although it is recognized that the BAZ may extend to 12-15 inches depending on the organisms being examined). Specific sample handling requirements are necessary to minimize and control for the introduction of confounding factors.

5.9 Habitat Delineation and Assessment

Field investigations will be conducted to characterize ecological communities including submerged aquatic vegetation (SAV), wetlands, mud flats and vegetated shoreline areas, both to support the ecological risk assessment and to document communities that may be disturbed or removed completely during potential future remedial actions. Obtaining adequate documentation to characterize these communities requires data collection regarding the size, location, and composition of the communities, as well as information on the sediment, soil, and hydrologic parameters that support the communities.

SAV habitat assessment and delineation will consist of several components. SAV beds located in or adjacent to contaminated sediment areas will be documented for species composition, location, and acreage. Sediment samples will be collected to analyze for TOC, grain size, pH, and macro- and micronutrients throughout the beds. Water quality measurements will include temperature, pH, and dissolved oxygen (DO). Finally, porewater chemistry samples will be taken to document baseline conditions in the beds.

Wetlands investigation along the Passaic River will focus on areas that are expected to be impacted by site contaminants and that are located in the river or entirely within 100 feet of the shoreline. Soil/sediment samples will be collected and analyzed for physical and chemical parameters including organic and nutrient content, and functional assessments of the wetlands will be performed.

Shoreline areas will be evaluated for community characteristics and physical, chemical, and hydrologic conditions. Reference shoreline communities will be described by species composition, age, and density along transects established by project field personnel. Soil samples will be collected and analyzed in a manner similar to that of SAV and wetland samples and will include soil characterization based on U.S. Geological Survey (USGS) Soil Survey data.

5.10 Candidate Restoration Site Sampling

5.10.1 Candidate Restoration Sites Soil and Sediment Investigations

Future data needs for candidate restoration sites will encompass both geotechnical and environmental sampling to satisfy the following objectives:

- Determine whether candidate site soil/sediment contaminant concentrations exceed NJDEP Site Remediation Criteria and/or are likely to have an adverse impact on site restoration (*e.g.*, plantings, biota).
- Determine candidate site soil/sediment geotechnical properties to support restoration feasibility analyses.
- Determine soil geotechnical properties in Passaic River bank areas to evaluate slope stability and whether bank stabilization measures may be required during remedial dredging.
- Provide data necessary for the affected environment section of the National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS).

Based on these data needs, once restoration sites are selected a detailed sampling program will be developed in consideration of site-specific conditions. Presented below is an overview of studies and sampling methodologies that are likely to be performed at candidate restoration sites.

- <u>Geotechnical Investigation</u> - Site-specific geotechnical testing will be performed to quantify in-situ soil and sediment properties at areas selected for shoreline softening, public access, and also for areas selected for wetland restoration/rehabilitation. Geotechnical engineering studies will be performed for slope stability analysis of the shoreline, re-contouring of wetlands sediment, construction of bulkheads along the riverbanks, the removal of riprap and contouring of the riverbank. Geotechnical analyses may also be conducted in areas other than candidate restoration sites where information is necessary to assess the potential impacts of contaminated sediment dredging on shoreline slope stability.
- <u>Hazardous/Toxic/Radiological Waste Investigation</u> - HTRW investigations will be conducted in accordance with guidance provided in the "Water Resources

Policies and Authorities - Hazardous, Toxic and Radioactive Waste Guidance for Civil Works Projects" (EM 1165-2-132; USACE, 1992), "Engineering and Design - Requirements for the Preparation of Sampling and Analysis Plans" (EM 200-1-3; USACE, 2001), and CERCLA remedial investigation guidance. A report will be prepared which describes detected HTRW occurrences within, or nearby, the project areas. It will include a preliminary determination of the nature and extent of detected contamination as well as quantitative and qualitative analyses of contamination impacts in the absence of response actions. HTRW site inspections will be conducted for the ecosystem restoration projects in support of alternative plan development. Soil samples may be collected using conventional drilling rigs, or direct push technology (DPT).

5.10.2 Candidate Restoration Sites Water Quality Investigations

Future data needs for selected restoration sites will encompass both water quality and HTRW sampling to satisfy the following objectives:

- Determine whether groundwater/surface water contaminant concentrations exceed NJDEP Site Remediation Criteria and/or are likely to have an adverse impact on site restoration (*e.g.*, plantings, biota).
- Provide data necessary for the affected environment section of the NEPA-EIS.

5.10.3 Candidate Restoration Sites Cultural Resource Surveys

Cultural resource surveys will be conducted to identify resources on or near candidate sites and evaluate their eligibility for inclusion on the National Register of Historic Places. Restoration planners will then be able to evaluate how to best avoid or minimize any impacts to eligible resources. An evaluation of the impact of alternative plans on eligible properties will be developed in consultation with the State Historical Preservation Officer (SHPO). If eligible resources cannot be avoided, a Memorandum of Agreement (MOA) will be developed in consultation with the appropriate SHPO(s) to mitigate for unavoidable impacts. Any work stipulated in the MOA will be undertaken prior to initiation of project construction unless otherwise agreed with the SHPO(s).

5.10.4 Candidate Restoration Sites Socioeconomics

The objective of socioeconomic analyses is to measure the cost effectiveness, social fairness, and institutional implementability of each remediation and restoration plan proposed for the contaminated environmental media in the Lower Passaic River and the candidate restoration sites. The study period for all evaluations will be 50-years to be consistent with the FS requirements.

5.10.5 Candidate Restoration Sites Real Estate Surveys

According to "Real Estate Handbook" (ER 405-1-12; USACE, 1985), a Real Estate Plan (REP) is the real estate work product that supports project plan formulation. It identifies and describes the lands, easements, and rights-of-way (LER) required for the construction, operation, and maintenance of a proposed project, including those required for relocations, borrow material and dredged or excavated material disposal.

6.0 DATA PRESENTATION

6.1 PREmis Overview

PREmis is designed to collect, store, manage and report historical data as well as data and information that will be collected during the CERCLA RI/FS and the WRDA ecosystem restoration investigation and FS. PREmis is also designed to provide effective project communication and to coordinate the project team working under both WRDA-funded and CERCLA-funded activities. Refer to Section 4.7, Web Site and GIS System, of the Final Passaic River Estuary Pre-Expansion Activity Plan, dated February 21, 2003, for a detailed description of PREmis.

PREmis is a centralized, web-based portal to the various forms of electronic information collected and stored for the project. At present, PREmis provides project team members access to information on project contacts, schedules, communications, project management, historical information, planning documents, and GIS mapping and reports. Since PREmis was created with a modular format, it can be upgraded as needed as the project proceeds. Currently, Malcolm Pirnie will be expanding PREmis' capabilities through creation of a wireless field application and data upload and validation modules.

6.2 Objectives

The main objectives for PREmis are to:

- Provide a central location for project information including large volumes of field electronic data
- Establish a unified Passaic/Hackensack/Newark Bay database
- Provide timely access to data and documents
- Deliver a variety of reports in a variety of formats, from on-screen tabular web reports and downloadable data sets for off-line analysis to GIS based visual reports
- Ensure defensible information
- Allow different levels of users to access the site through a multi-tiered security plan
- Track all data and documents through an on-line validation, review and approval processes from remote locations
- Automate the capture of field data.

6.3 PREmis Description

The system uses a combination of different technologies including:

- MapGuide - a web GIS interface to display analytical and shape file data
- ColdFusion as the main programming environment
- Various Web technologies to upload, download and report information

To facilitate communication between all team members on a real-time basis, the system allows team members located inside various Malcolm Pirnie offices, team members operating remotely from the field, and team members from various agencies (*e.g.*, USEPA, USACE, OMR) as well as subconsultants (*e.g.*, Rutgers, U.S.G.S., HydroQual, and Battelle) to enter, manage and report data. The flow chart of how data presentation will be handled by PREmis is presented in Figure6-1. The use of Internet technologies such as Web Servers, Web Browsers, Firewalls and e-mail provides the type of flexibility and security needed for this system.

Users have access to the system via standard Web Browsers and log onto a private web server located in Malcolm Pirnie's White Plains office. All users have separate ids and passwords, and have been assigned to different user access levels. All data for the system is stored in ColdFusion and is accessible through both pre-defined reports and ad-hoc query capabilities. Also, data download capabilities have been added as part of the reporting area.

6.4 PREmis Utilities:

PREmis utilizes the following modules for this project.

6.4.1 Management

This module includes budget tracking, scheduling, and project task tracking. The project management module also provides a platform for performing task specific discussions to ensure the project is meeting client needs and maintaining quality standards. The reporting function of PREmis also assists in project management by allowing users to generate key management reports.

6.4.2 Data Storage

PREmis provides a platform for the electronic storage of documents and information. The documents are stored in the digital library and are coded with attributes that allow the user to query the reports based on key words (*e.g.*, return all documents with information on dioxin analyses). The information is contained in a unified database that was developed to be consistent with USEPA's Multi media electronics data deliverable (MEDD) requirements. This database will be the repository for all historical data as well as data collected during on-going RI/FS activities.

6.4.3 Data Upload

The data upload function of PREmis allows users to upload data from various sources such as laboratory electronic data deliverables (EDDs) and field instrument readouts. The interactive module allows users to upload ASCII files containing data directly into the website; the data is then reviewed and approved by the site quality control officer (SQO) prior to being available to the entire project team.

6.4.3.1 Field Application:

The field application will be used by the sampling teams while performing field sampling of the Lower Passaic River and its tributaries. The field application allows users to collect field information electronically instead of manually into field notebooks. The field application is able to support different sampling events (*e.g.*, surface water/water column sampling, sediment sampling, hydrodynamic monitoring) through the creation of sample specific modules. The field application will also allow users to periodically download instrument readouts from various instruments such as OBS, CTD, and ADCP and will assist in uploading the information into PREmis database after the data has been reviewed and approved by the SQO or a designee.

6.4.4 Evaluation

The GIS Mapping/Map Guide and report functions of PREmis will assist the project team in assessing problems, formulating and evaluating solutions, and presenting findings. The GIS Mapping/Map Guide portion of PREmis provides a means for all project team members to easily access, display and query map and sample data stored in either ESRI shape files or the PREmis database. The report tool will assist users in querying information based on various attributes.

6.4.4.1 GIS Mapping/Map Guide

With its interactive spatial query tool, GIS Mapping/Map Guide allows users to query information based on a selected study area and then view reports, documents and data related to the study area. It also gives users the ability to create custom spatial views of data and allows users to save their custom views of data to a personal library. By saving their MapGuide data views, users can simply pick a saved view from their personal list and MapGuide automatically retrieves and display the results. In addition, users have the ability to save their personal data views to a public list enabling other team members to see their MapGuide results.

To assist team members in their analysis of sample data, a MapGuide interface displays various GIS layers of the study area and sample data stored in PREmis database. These layers, referred to as themes, are data layers stored in the shape files and viewed through MapGuide. Themes that may be included in PREmis include soils, vegetative cover, wetlands, topography, hydrology, tidal reach and elevations, water and sediment quality sample locations, property ownership, land use/cover, zoning, demographic data, regulatory floodplain boundaries, stream bathymetry, Hazardous, Toxic and Radioactive Waste (HTRW), and cultural sites information. At present, the interface gives users the ability to:

- Turn off and on various map themes incorporated into the shape files
- Customize the MapGuide display of sample data results
- Create ad-hoc queries for sample data by date, chemical class, location (*e.g.*, township, river mile, reach), sample type, depth and evaluation criteria such as those reflected in Applicable or Relevant and Appropriate Requirements (ARARs) determined for the project
- Drill down into sample results for a particular location
- Create and store custom MapGuide “views” by user
- Generate tabular reports from selected data
- Download sample data into either MS Access or Excel

7.0 HYDRODYNAMIC, SEDIMENT TRANSPORT, CHEMICAL FATE and TRANSPORT, and BIOACCUMULATION MODELING

7.1 Overview

A set of models designed to simulate the physical, chemical and biological processes occurring within the Lower Passaic River Study Area are being implemented to evaluate the risks posed to human health and the environment from the transport of sediment and associated contaminants. The integrated modeling framework is needed to determine the fate of contaminants released into the environment under both current conditions and future scenarios, and thus to produce scientifically defensible support for regulatory decision-making.

7.2 Purpose and Objective of the Lower Passaic River Modeling

The main purpose of the modeling effort is to predict future concentrations of the COCs in the study area under different management scenarios (*e.g.*, dredging, monitored natural attenuation, capping). Specifically, the model will be used to establish the magnitudes and relative importance of specific contaminant sources to the 17-mile tidal reach of the Passaic River, including:

- Upstream loads from above the Dundee Dam
- Loads from tributaries and other point sources along the 17-mile tidal reach
- Re-mobilization of contaminants within the 17-mile tidal reach
- Inputs from water bodies hydraulically connected to the down-estuary end of the 17-mile tidal reach via Newark Bay (including, for example, re-introduction of contaminants originating from within the 17-mile tidal reach, or seasonal inputs from the Upper New York Harbor), and
- Sediment and chemical contaminant re-mobilization due to current or future dredging operations that may occur in water bodies hydraulically connected to the Passaic River

The models will also provide management guidance for the adverse ecological and human health effects of the transport and ultimate fate of the chemical of concern within the system. Additionally, the models will be used to assess the amount and extent of sediment and chemical contaminant re-mobilization due to various remedial action alternatives that may be conducted within the 17-mile tidal reach of the Passaic River during the period of remediation, as well as during the recovery period. Lastly, the models will be used to assess sediment quality and contaminant levels if loadings are reduced or eliminated; and the time frame for improvement under various remedial action alternatives.

7.3 Model Framework and Approach

The model framework used for the Lower Passaic River Modeling Study includes model components describing hydrodynamics, sediment transport and organic carbon cycling, toxic fate and transport, and bioaccumulation as shown in Figure 7-1. The model will be run with a fine spatial and temporal resolution with the capability of capturing the dynamics of individual storm events as well as long-term transport, fate and bioaccumulation processes within the Study Area. Ex. 5 predecisional and delberative

Ex. 5 predecisional and delberative

Hydrodynamic model calculations will first be performed to determine intra-tidal transport, currents and bottom shear stresses throughout the model domain. This portion of the model suite uses the model inputs of flow upstream and from tributary inputs, downstream tidal action, temperature and salinity as well as atmospheric inputs such as wind speed and solar radiation to simulate the flow, dispersion, stratification and currents within the estuary. In addition to transporting material by advection, the flow imparts a shear stress on the bed, which at a threshold value determined by the bed properties such as porosity and grain-size distribution will re-mobilize the bed sediments and associated contaminants.

This information will be passed forward to a sediment transport/organic carbon cycling model to determine the movement of inorganic particles and organic carbon between the overlying water and the bed. Organic carbon cycling is considered explicitly with sediment transport for three important reasons. The first reason is that particulate organic carbon (POC) can be a significant part of the suspended sediment concentrations, particularly in surface waters of the harbor. Secondly, POC can affect the movement of inorganic particles through coagulation, resuspension, and sediment mixing processes. Third, organic carbon, and not sediment *per se*, is important in controlling the distribution of toxic contaminants between the dissolved and particulate phases in subsequent model calculations.

In turn, information from the hydrodynamic and sediment transport/organic carbon cycling models will be passed forward to a chemical fate and transport model, and will be used along with descriptions of contaminant partitioning to organic carbon and other contaminant processes (*e.g.*, volatilization, degradation) to determine contaminant concentrations in the overlying water and sediment. Finally, contaminant concentrations in the water column and sediment will be used in bioaccumulation and toxicity calculations.

The specific models that will be used in the Study Area are shown in Figure 7-1. A summary of processes included in the various models and detailed model descriptions for these processes is described in the Modeling Work Plan (HydroQual, 2004). Model calibration for the hydrodynamic and sediment transport/organic carbon cycling models will be performed for select USGS water years (October-September). Chemical fate and bioaccumulation model calibration for the contaminants of concern will be performed for present conditions.

The availability of information on historical sediment and contaminant loads, a time-variable model calculations will also be performed as a model hindcast for select contaminants to ensure that time constants in the model are properly calibrated. These evaluations form the basis for an overall assessment of the model. Further, component load analyses and model projections (scenarios) under various scenarios will be performed and compared with the above described base runs. Details of model calibration, assessment, load analyses and projections are described in the Modeling Work Plan.

8.0 RISK ASSESSMENT

8.1 Overview

Human health and ecological risk assessments will be conducted for the Lower Passaic River Restoration Project, in conjunction with the CERCLA RI/FS. The objectives of these assessments are to assist risk managers at Superfund sites in making informed decisions regarding the presence of hazardous substances.

8.2 Sediment Screening Level Investigations

As part of the investigation being conducted for the Lower Passaic River Restoration Project, a human health and ecological risk assessment will be conducted. As the initial step in the risk assessment process, contaminant levels in the relevant environmental media will be screened against conservative benchmarks to identify which chemicals need to be more fully assessed and which chemicals are not at levels that may cause harm to human health and the environment.

The selection process for identifying COPCs for the human health evaluation will be determined based on frequency of detection, identification as Class A carcinogens, and magnitude of concentration relative to existing risk-based benchmark values. A summary of the screening process is provided below and in Figures 5-1 and 5-2.

8.2.1 Human Health Screening Process

- All Class A carcinogens will be considered COPCs in future evaluations and will be included in any sampling program regardless of their frequency of detection. However, those chemicals not identified as Class A carcinogens can be excluded from further evaluation if they are detected in less than five percent of the samples collected.
- The maximum concentration of each analyte will be compared against conservative, risk-based screening values to identify COPCs for human health evaluation. Chemicals with maximum concentrations exceeding the screening values will be identified as COPCs while chemicals with concentrations below the screening values will be excluded from further analysis. When benchmarks are not available, the compound will be retained as a COPC. Background and ambient conditions will not be considered in the selection of COPCs.

8.2.2 Ecological Screening Process

The process for screening chemical constituents for the protection of ecological receptors consists of four tiers that include: 1) frequency of detection screen; 2) essential nutrient screen; 3) effects benchmark screen; and 4) bioaccumulation screen. Maximum concentrations of all chemicals will be used for this screening process.

- In the first step, the frequency of detection of each chemical will be evaluated. Chemicals detected in less than five percent of the samples evaluated will be eliminated from further consideration. In addition, constituents considered to be 'essential nutrients' will be excluded for consideration as COPCs.

- The maximum sediment concentrations of all non-essential nutrients detected in greater than five percent of samples will be screened against a hierarchy of effects-based sediment benchmarks. This evaluation will be based preferentially on sediment quality guidelines developed by NOAA; NOAA (1991) defines two screening benchmarks, the Effects Range Low (ER-L) and the Effects Range Median (ER-M) (Long and Morgan 1991; Long *et al*. 1995).

- Contaminants for which NOAA benchmarks are unavailable will be screened against other available effects-based benchmarks including those developed or recommended by Oak Ridge National Laboratory (ORNL) in Jones *et al*. (1997), Florida Department of Environmental Protection (FDEP) (MacDonald 1994), and USEPA (USEPA 1993, 1996).

- Radioactive constituents will be screened against benchmarks developed by ORNL in conjunction with Bechtel Jacobs Company (BJC 1998). Two types of benchmarks will be derived; single-media benchmarks and multimedia benchmarks. All benchmarks include exposures from parent isotopes and all short-lived daughter products. They also include exposures from all major alpha, beta, and gamma emissions for each isotope (BJC 1998). The single-media benchmarks are based on exposures to radionuclides in one medium but not the other, and are intended to be used when both water and sediment data are available. The multimedia benchmarks are for use when only one medium is sampled at a site. Because this preliminary screening will be based only on sediment data, the benchmarks used in the screening will be taken from the BJC (1998) list of multimedia benchmarks.

- Chemicals for which no effects-based sediment benchmark values are readily available will be retained as COPCs. As part of future risk assessment activities, a literature review will be conducted to identify appropriate screening values for chemicals lacking benchmarks.

- To ensure that bioaccumulative compounds are adequately addressed, chemical constituents detected in greater than five percent of samples will be compared with a list of bioaccumulative compounds published by USEPA Region 9

(Hoffman 1998). Any Region 9 bioaccumulative constituent that is detected in greater than five percent of samples will be identified as a COPC, regardless of its concentration relative to its respective effects-based benchmark value.

8.3 Human Health Assessment

The human health assessment will be focused on potential human health impacts associated with exposure to site-related contamination within the 17 mile stretch of the Passaic River. The human health assessment will follow all applicable and relevant guidance (EPA, 1989; 1992, 2001). A two-tiered approach will be followed, designed to support risk management decision-making by initially defining the COPCs for each media based on existing data and using this information to prioritize areas requiring further assessment. In the first tier, described in the PAR, data collected from historical field investigations were compared against existing risk-based preliminary remediation goals (PRGs) developed by USEPA Region 9 (2002). The purpose of this initial tier was to identify the primary COPCs and complete exposure pathways under future and current conditions such that a more focus field investigation may be implemented to attain relevant data for the human health risk assessment.

Based on available information about current activities, as well as ongoing initiatives to restore the Passaic River, it was assumed that human exposure to contaminants in the river sediments would be associated with recreational activities such as swimming, wading, fishing, crabbing, and boating. Human receptors identified as engaging in these activities include a Recreational User and an Angler/Sportsman. In addition, a transient community has occasionally constructed temporary housing along the banks of the river. There is limited information regarding the length of their occupancy and their activities while on the river; however, a residential scenario was also included in the conceptual site model to address potential exposures to this community. The receptors and exposure scenarios associated with future use are not expected to differ significantly from those being evaluated under the current use scenarios. Consumption of fish and other aquatic organisms anticipated to be the primary exposure pathway.

In the second tier of the human health assessment, a more thorough analysis of the available data and supporting exposure assumptions will be evaluated to determine if site-specific data collection may be required of key parameters in order to minimize the associated uncertainties in the follow-on risk assessment. Specific data collection needs will follow the DQO process and will be provided in the FSP.

8.4 Ecological Risk Assessment

The objective of the ecological evaluation is to evaluate and characterize the potential for adverse effects to ecological receptors associated with exposure to COPECs present in environmental media within the Study Area. To evaluate these potential risks, ecological risk assessment (ERA) guidance from U.S. EPA (1992, 1997a) will be followed, specifically a tiered process that encompasses eight steps. In the first tier, a screening-level ecological risk assessment (SLERA) is conducted (encompassing Steps 1 and 2 of EPA guidance) which consists of a preliminary conceptual site model (CSM), identification of COPECs, and screening-level dose assessment using conservative assumptions. The second tier or baseline ecological risk assessment (BERA) (Steps 3 through 7 of the EPA process) uses the output from the SLERA to refine the problem formulation stage and further evaluate any COPECs that may cause an adverse effect to receptors of concern. Exposure and effects will be assessed for all endpoints defined in the problem formulation step and used to characterize risks to ecological receptors.

Based on an evaluation of the likely food web for the Passaic River, complete ecological exposure routes for higher-trophic level organisms are likely to be associated with ingestion of contaminated prey, particularly benthic invertebrates and fish, and direct/incidental ingestion of sediment and (to a lesser extent) surface water. For the purposes of future assessment of risk to ecological receptors, these will be considered the primary routes of exposures for mammals and birds at the Lower Passaic River Restoration site.

If the SLERA determines an unacceptable risk to wildlife, the site will move toward a BERA. The BERA will expand on particular ecological concerns at the site, following input from stakeholders and other involved parties. In the SLERA, conservative assumptions were used where site-specific information was lacking. The BERA, however, will be more specific and encompass new data that was compiled during the site investigation, such as tissue concentrations and toxicity data. Specific data collection needs will follow the DQO process and will be provided in the FSP.

9.0 GLOSSARY AND ACRONYMS

2,4-D	2,4-Dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxy)acetic acid
AOC	Administrative Order of Consent
APE	Area of Potential Effect
ARAR	Applicable or Relevant and Appropriate Requirements
BAZ	Biologically Active Zone
BERA	Baseline Ecological Risk Assessment
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet per Second
CLH	Chemical Land Holdings
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSO	Combined Sewer Outfall
CTD	Conductivity, Temperature, and Depth
DDT	4,4'-dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DPT	Direct Push Technology
DQO	Data Quality Objectives
EDD	Electronic Data Deliverable
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ER-L	Effects Range Low
ER-M	Effects Range Median
ETM	Estuarine Turbidity Maximum
^{o}F	Degrees Fahrenheit
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
FSP	Field Sampling Plan
GIS	Geographical Information System
HMW	High Molecular Weight
HTRW	Hazardous Toxic and Radioactive Waste
LER	Lands, easements, and rights-of-way
LMW	Low Molecular Weight
MEDD	Multi-media Electronic Data Deliverable
MLW	Mean Low Water
NAWQC	National Ambient Water Quality Criteria
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NJ	New Jersey
NJDEP	N.J. Department of Environmental Protection
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List

NRC	National Research Council
NY	New York
NYSDEC	N.Y. State Department of Environmental Conservation
NYSDOH	N.Y. State Department of Health
OCC	Occidental Chemical Company
OMR/NJDOT	New Jersey Department of Transportation
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PAR	Pathways Analysis Report
PCB	Polychlorinated Biphenyl
PCDD	polychlorinated Dibenzo-p-dioxins
PES	Particle Entrainment Simulator
PMP	Project Management Plan
POTW	Publicly Owned Treatment Works
PREmis	Passaic River Estuary Management Information System
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
PRSA	Passaic River Study Area
PVSC	Passaic Valley Sewerage Commissioners
QAPP	Quality Assurance Project Plan
REP	Real Estate Plan
RI	Remedial Investigation
RM	River Mile
SAP	Sampling and Analysis Plan
SHPO	State Historical Preservation Officer
SLERA	Screening Level Ecological Risk Assessment
SAV	Submerged Aquatic Vegetation
SQG	Sediment Quality Guideline
SQO	Site Quality Control Officer
SVOC	Semi-Volatile Organic Carbon
TAMS	TAMS/EarthTech, Inc
TEPH	Total Extractable Petroleum Hydrocarbon
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TMDL	Total Maximum Daily Load
TPH	Total Petroleum Hydrocarbon
TSI	Tierra Solutions, Inc.
TSS	Total Suspended Solid
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WP	Work Plan
WRDA	Water Resources Development Act

10.0 REFERENCES

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Table 2-1
Lower Passaic River Restoration Project
Summary of CSOs in the Passaic River

CSO #	Name	Location	Owner	Status		LATITUDE		LONGITUDE	RECEIVING WATERBODY
1	Curtis Place	Paterson	Paterson	Active	N	40.91955744	W	-74.17605623	PASSAIC RIVER
2	Mulberry Street	Paterson	Paterson	Active	N	40.92011366	W	-74.17540063	PASSAIC RIVER
3	West Broadway	Paterson	Paterson	Active	N	40.92078742	W	-74.17480113	PASSAIC RIVER
4	Bank Street	Paterson	Paterson	Active	N	40.92131086	W	-74.17425219	PASSAIC RIVER
5	Bridge Street	Paterson	Paterson	Active	N	40.92307858	W	-74.16987565	PASSAIC RIVER
6	Montgomery Street	Paterson	Paterson	Active	N	40.92504566	W	-74.1668825	PASSAIC RIVER
7	Straight Street	Paterson	Paterson	Active	N	40.92612198	W	-74.16577762	PASSAIC RIVER
8	Franklin Street	Paterson	Paterson	Active	N	40.92649528	W	-74.16542827	PASSAIC RIVER
9	Keen Street	Paterson	Paterson	Active	N	40.92724333	W	-74.16501875	PASSAIC RIVER
10	Warren Street	Paterson	Paterson	Active	N	40.9279176	W	-74.16486462	PASSAIC RIVER
11	Sixth Avenue	Paterson	Paterson	Active	N	40.93424146	W	-74.16642248	PASSAIC RIVER
13	E. 11th Street	Paterson	Paterson	Active	N	40.93698444	W	-74.1569832	PASSAIC RIVER
14	Fourth Avenue	Paterson	Paterson	Active	N	40.93723503	W	-74.15574227	PASSAIC RIVER
15	S.U.M. Park	Paterson	Paterson	Active	N	40.91766503	W	-74.1797415	PASSAIC RIVER
16	Northwest Street	Paterson	Paterson	Active	N	40.92139141	W	-74.17539027	PASSAIC RIVER
17	Arch Street	Paterson	Paterson	Active	N	40.92334229	W	-74.17012051	PASSAIC RIVER
21	Bergen Street	Paterson	Paterson	Active	N	40.92904461	W	-74.16514483	PASSAIC RIVER
22	Short Street	Paterson	Paterson	Active	N	40.93101362	W	-74.16680416	PASSAIC RIVER
23	Second Avenue	Paterson	Paterson	Active	N	40.93849243	W	-74.14280616	PASSAIC RIVER
24	Third Avenue	Paterson	Paterson	Active	N	40.93637785	W	-74.14104983	PASSAIC RIVER
25	33rd Street & 10th Avenue	Paterson	Paterson	Active	N	40.9239142	W	-74.14047266	PASSAIC RIVER
26	20th Avenue	Paterson	Paterson	Active	N	40.90545931	W	-74.13224861	PASSAIC RIVER
27	Market Street	Paterson	Paterson	Active	N	40.90239889	W	-74.13407241	PASSAIC RIVER
67	Hudson Street	Paterson	Paterson	Active	N	40.92497747	W	-74.16826962	PASSAIC RIVER
28	Stewart Avenue	Kearny	Kearny	Active	N	40.77896986	W	-74.14772199	PASSAIC RIVER
29	Washington Avenue	Kearny	Kearny	Active	N	40.77677024	W	-74.14918854	PASSAIC RIVER
31	Nairn Avenue	Kearny	Kearny	Active	N	40.75896229	W	-74.16269243	PASSAIC RIVER
32	Marshall Street	Kearny	Kearny	Active	N	40.75603734	W	-74.16351313	PASSAIC RIVER
33	Johnston Avenue	Kearny	Kearny	Active	N	40.75423926	W	-74.16393242	PASSAIC RIVER
34	Ivy Street	Kearny	Kearny	Active	N	40.76176767	W	-74.14039016	FRANK'S CREEK
37	Duke Street	Kearny	Kearny	Active	N	40.75233594	W	-74.13981581	FRANK'S CREEK
38	Central Avenue	East Newark	East Newark	Active	N	40.75097986	W	-74.16466396	PASSAIC RIVER
39	New Street	Harrison	Harrison	Active	N	40.74734431	W	-74.16510358	PASSAIC RIVER
40	Cleveland Street	Harrison	Harrison	Active	N	40.74595681	W	-74.16512276	PASSAIC RIVER
41	Harrison Avenue	Harrison	Harrison	Active	N	40.74516906	W	-74.16508007	PASSAIC RIVER
42	Dey Street	Harrison	Harrison	Active	N	40.74392541	W	-74.16460475	PASSAIC RIVER
43	Bergen Street	Harrison	Harrison	Active	N	40.74290808	W	-74.16417641	PASSAIC RIVER
44	Middlesex Street	Harrison	Harrison	Active	N	40.74060601	W	-74.16316868	PASSAIC RIVER
45	Worthington Avenue	Harrison	Harrison	Active	N	40.73960351	W	-74.14422336	PASSAIC RIVER
46	Verona Avenue	Newark	Newark	Active	N	40.77651771	W	-74.15121519	PASSAIC RIVER
47	Delavan Avenue	Newark	Newark	Active	N	40.76856688	W	-74.15723593	PASSAIC RIVER

Table 2-1
Lower Passaic River Restoration Project
Summary of CSOs in the Passaic River

CSO #	Name	Location	Owner	Status		LATITUDE		LONGITUDE	RECEIVING WATERBODY
48	Herbert Place	Newark	Newark	Active	N	40.76528267	W	-74.15930066	PASSAIC RIVER
50	Fourth Avenue	Newark	Newark	Active	N	40.75616158	W	-74.16499307	PASSAIC RIVER
51	Clay Street	Newark	Newark	Active	N	40.75098545	W	-74.16579839	PASSAIC RIVER
76	Passaic Street	Newark	Newark	Active	N	40.75098545	W	-74.16579839	PASSAIC RIVER
77	Ogden Street	Newark	Newark	Active	N	40.75098545	W	-74.16579839	PASSAIC RIVER
54	Rector Street	Newark	Newark	Active	N	40.74114583	W	-74.16498813	PASSAIC RIVER
55	Saybrook Place	Newark	Newark	Active	N	40.74069462	W	-74.16474564	PASSAIC RIVER
56	City Dock	Newark	Newark	Active	N	40.73542444	W	-74.16189875	PASSAIC RIVER
57	Jackson Street	Newark	Newark	Active	N	40.73312292	W	-74.15501819	PASSAIC RIVER
58	Polk Street	Newark	Newark	Active	N	40.73311271	W	-74.15413036	PASSAIC RIVER
59	Freeman Street	Newark	Newark	Active	N	40.73406639	W	-74.14573431	PASSAIC RIVER
60	Peddie Street	Newark	Newark	Active	N	40.71070986	W	-74.18648354	PEDDIE DITCH
61	Queens District	Newark	Newark	Active	N	40.70635743	W	-74.18603914	QUEEN DITCH
62	Waverly District	Newark	Newark	Active	N	40.69047792	W	-74.19106382	WAVERLY DITCH
63	Yantacaw Pump Station	Clifton	PVSC	Relief Point	N	40.82137	W	-74.13047928	THIRD RIVER
64	Yantacaw Street	Clifton	PVSC	Relief Point	N	40.82159556	W	-74.13057626	THIRD RIVER
65	Wallington Pump Station	Wallington	PVSC	Relief Point	N	40.85754361	W	-74.11967586	PASSAIC RIVER
66	N. Arlington Branch	North Arlington	PVSC	Relief Point	N	40.78732424	W	-74.14613403	PASSAIC RIVER
69	Lodi Force Main	Passaic	PVSC	Relief Point	N	40.85698944	W	-74.11997697	PASSAIC RIVER
70	Passaic Tail Race	Passaic	PVSC	Relief Point	N	40.85762611	W	-74.11982333	PASSAIC RIVER
75	2nd River Joint Meeting	Newark	PVSC	Relief Point	N	40.77692778	W	-74.15071787	PASSAIC RIVER
001	Meadowbrook	Newark	Newark	Active	N	40.7872817	W	-74.17067965	Second River
006	Oriental	Newark	Newark	Active	N	40.76054118	W	-74.11888586	Passaic River
022	Roanoke	Newark	Newark	Active	N	40.72621861	W	-74.12096986	Newark Bay
023	Adams	Newark	Newark	Active	N	40.71198924	W	-74.16860515	Adams Ditch
024 & 030	Wheeler / Avenue A	Newark	Newark	Active	N	40.71295792	W	-74.18023238	Wheeler Ditch
	Newark Airport Peripheral Ditch	Newark	Newark		N	40.68818813	W	-74.15972907	Flows into Elizabeth Channel
028	Sum Park 2	Paterson	Paterson	Active	N	40.91729174	W	-74.18009014	PASSAIC RIVER
029	Loop Road	Paterson	Paterson	Active	N	40.92212059	W	-74.17215995	PASSAIC RIVER
030	19th Avenue	Paterson	Paterson	Active	N	40.90737302	W	-74.13247222	PASSAIC RIVER
031	Route 20 Bypass	Paterson	Paterson	Active	N	40.90138723	W	-74.13438519	PASSAIC RIVER

Figure 1-1
Lower Passaic River Restoration Project
Site Location Map

Figure 1-2
Lower Passaic River Restoration Project
Superfund Sites on the National 'Priorities' List

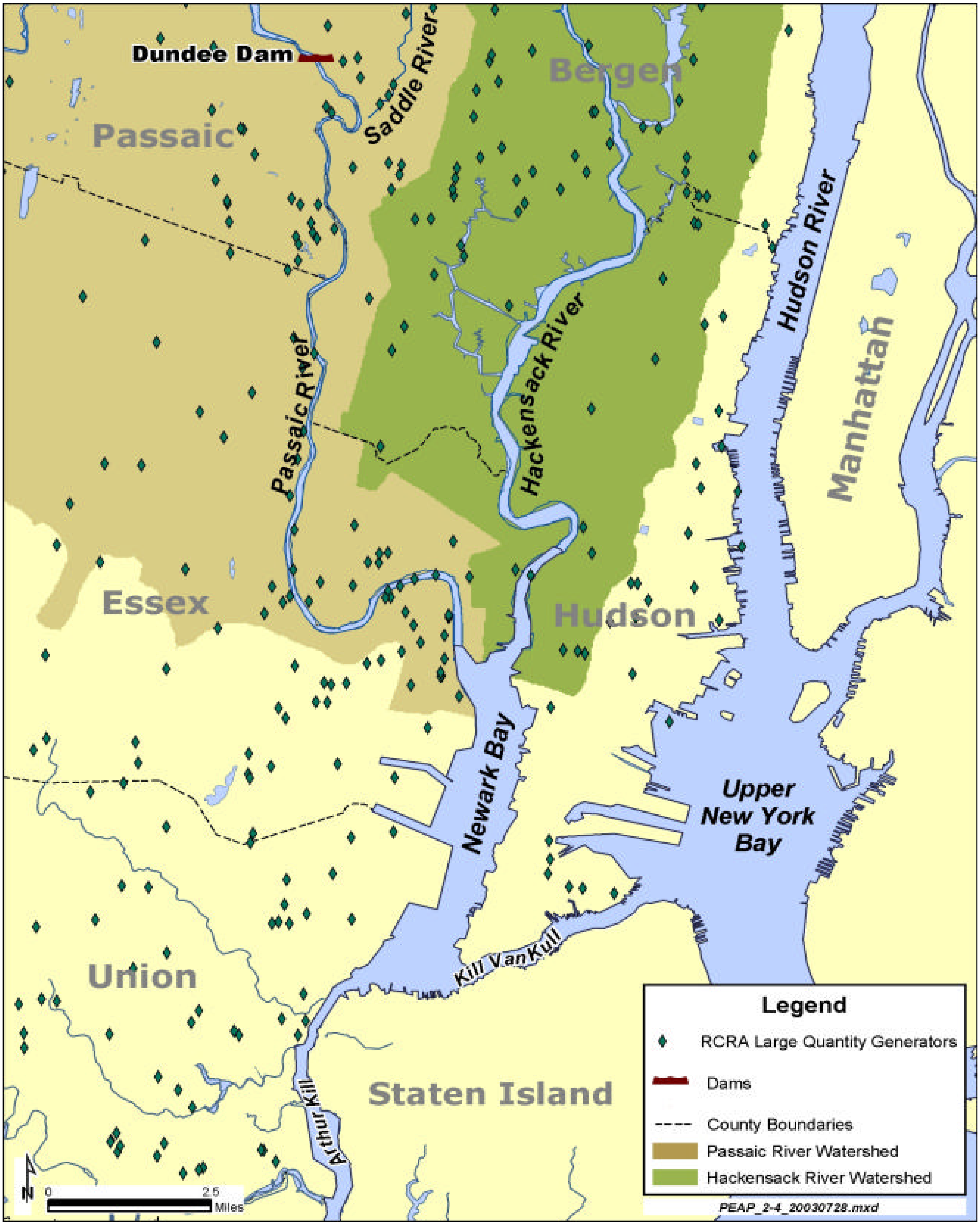


Figure 1-3
Lower Passaic River Restoration Project
Regulated RCRA Facilities

Image: 1995 DOQQs State of New Jersey

Paterson Area Outfalls

Figure 1-4

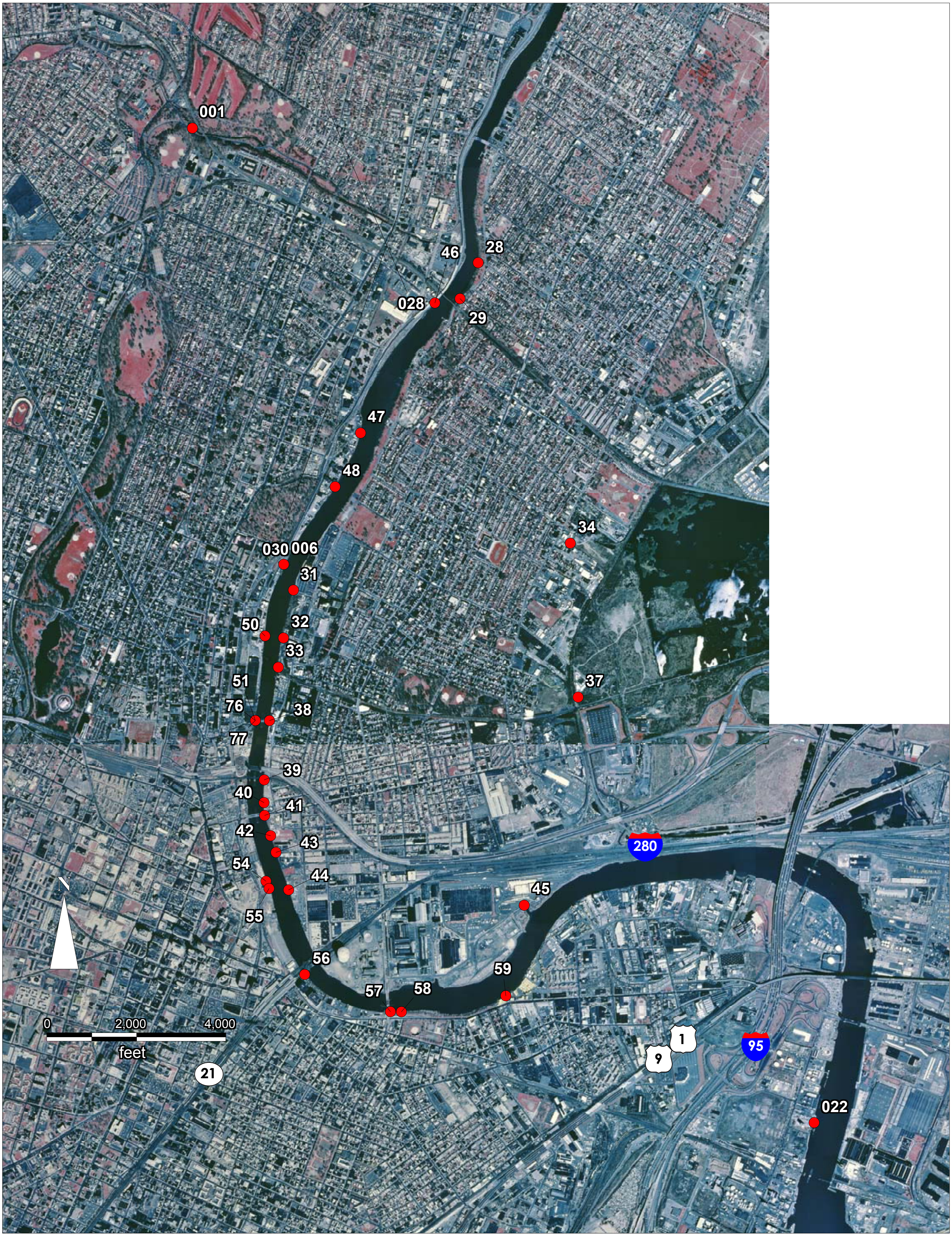
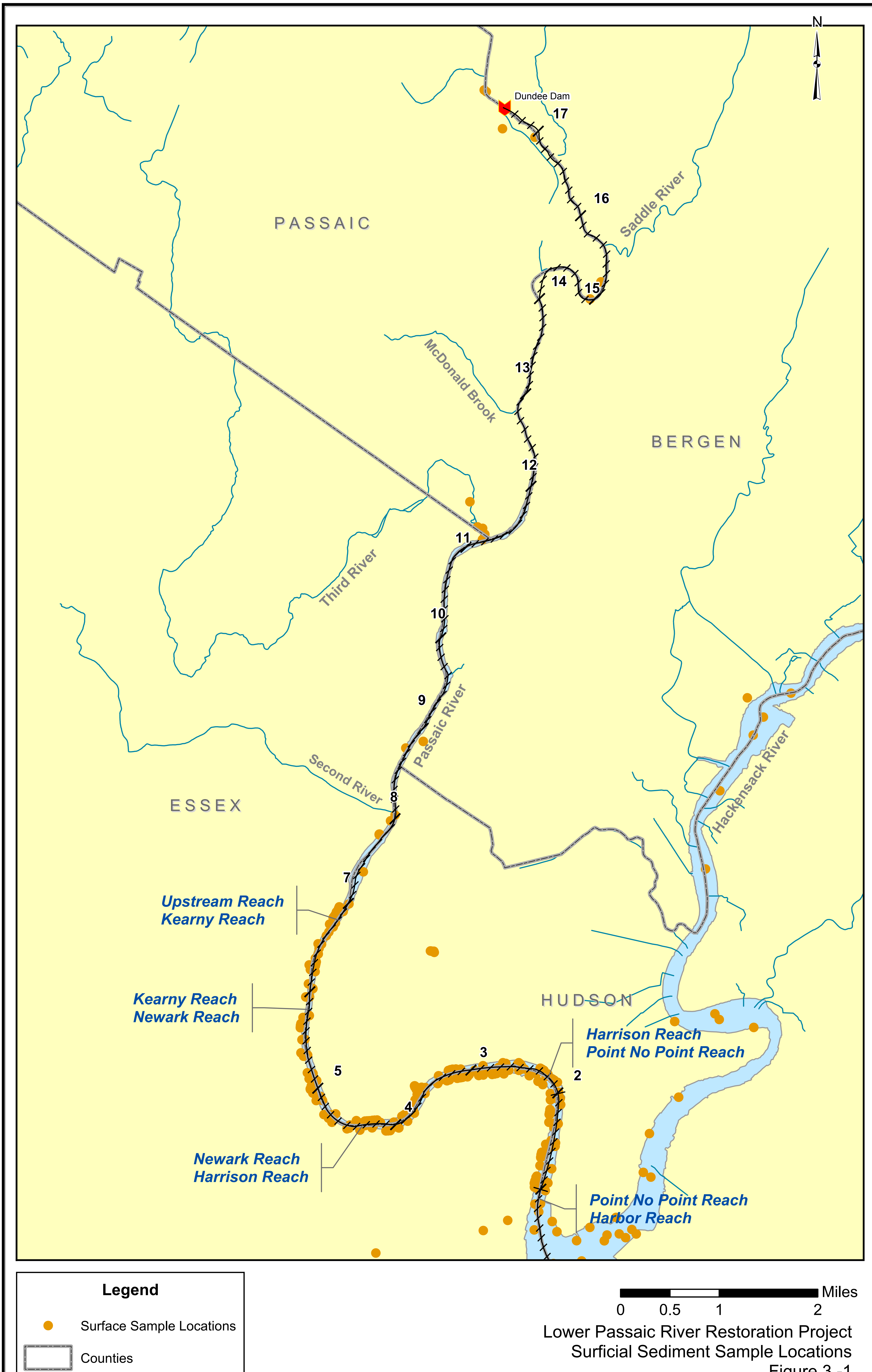


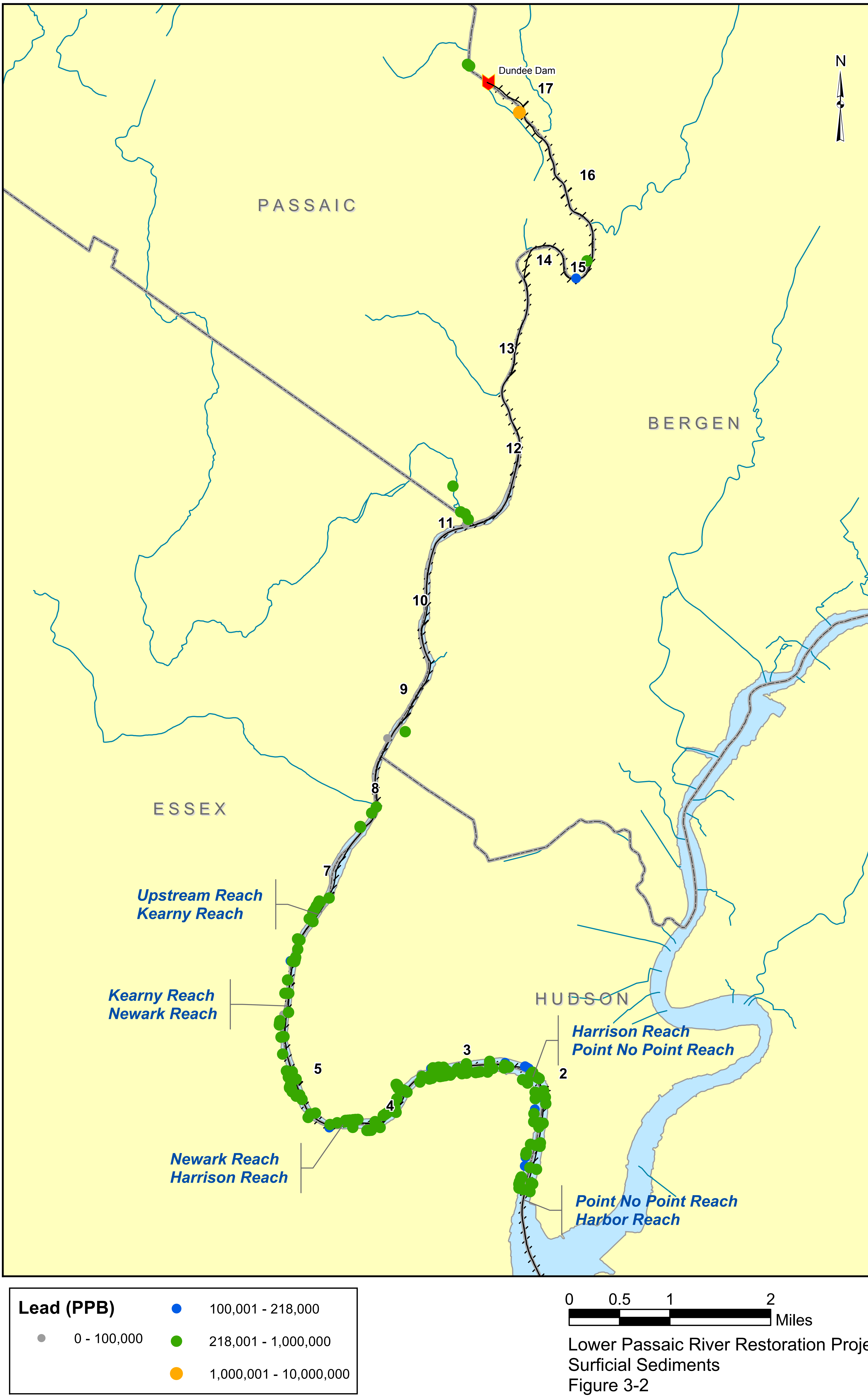
Image: 1995 DOQQs State of New Jersey

Newark Area Outfalls

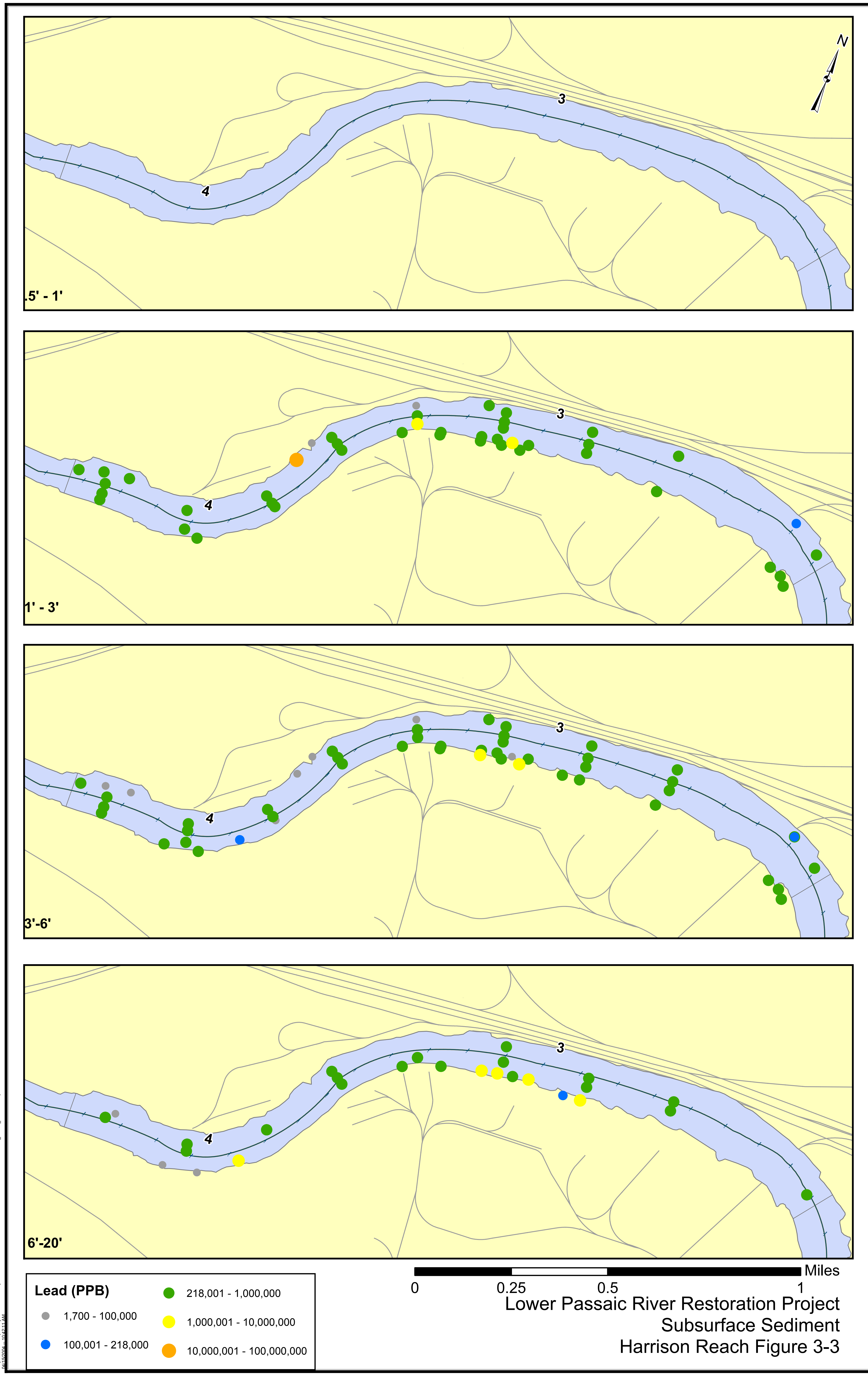
Figure 1-5



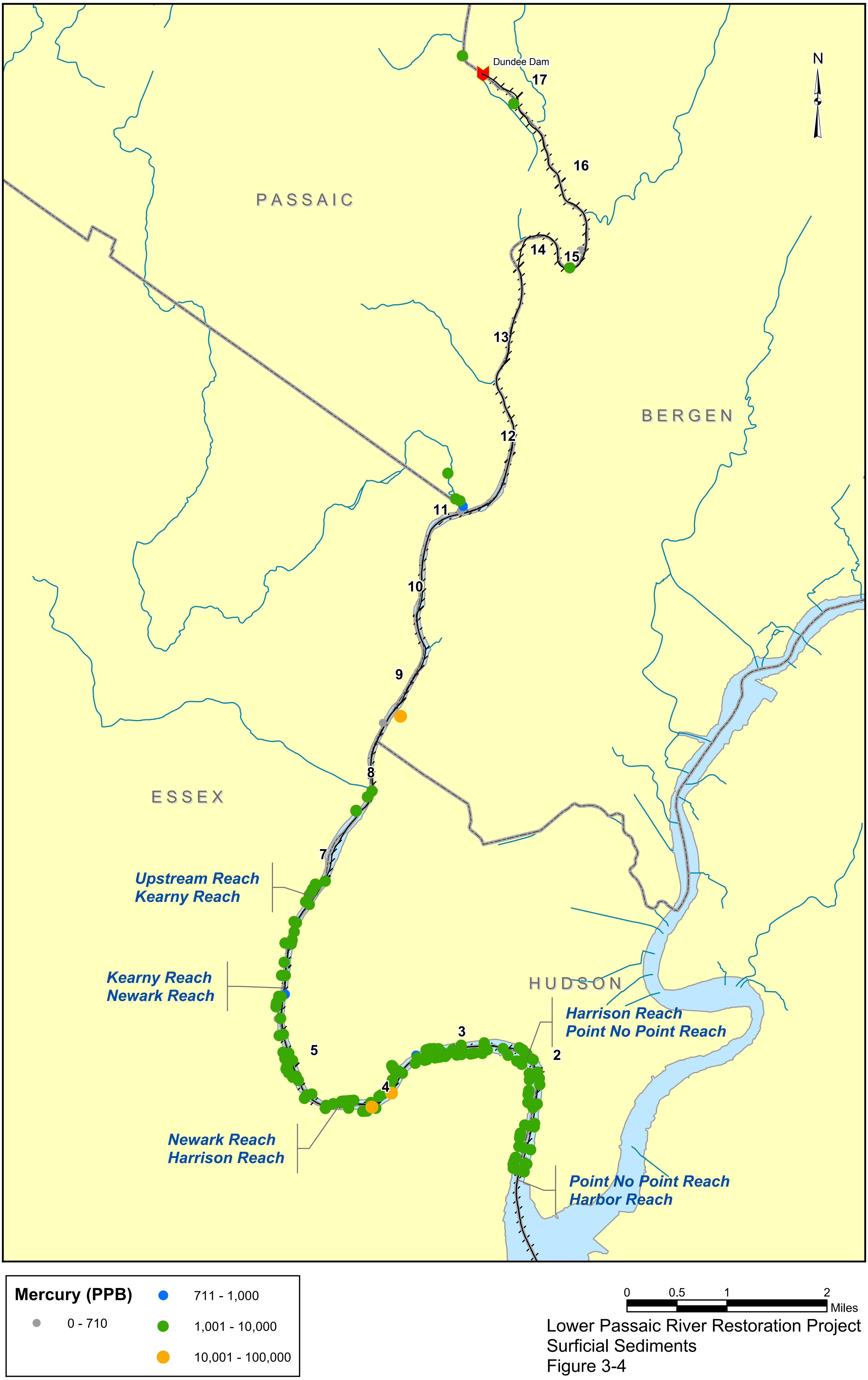
Lower Passaic River Restoration Project
Surficial Sediment Sample Locations
Figure 3 -1



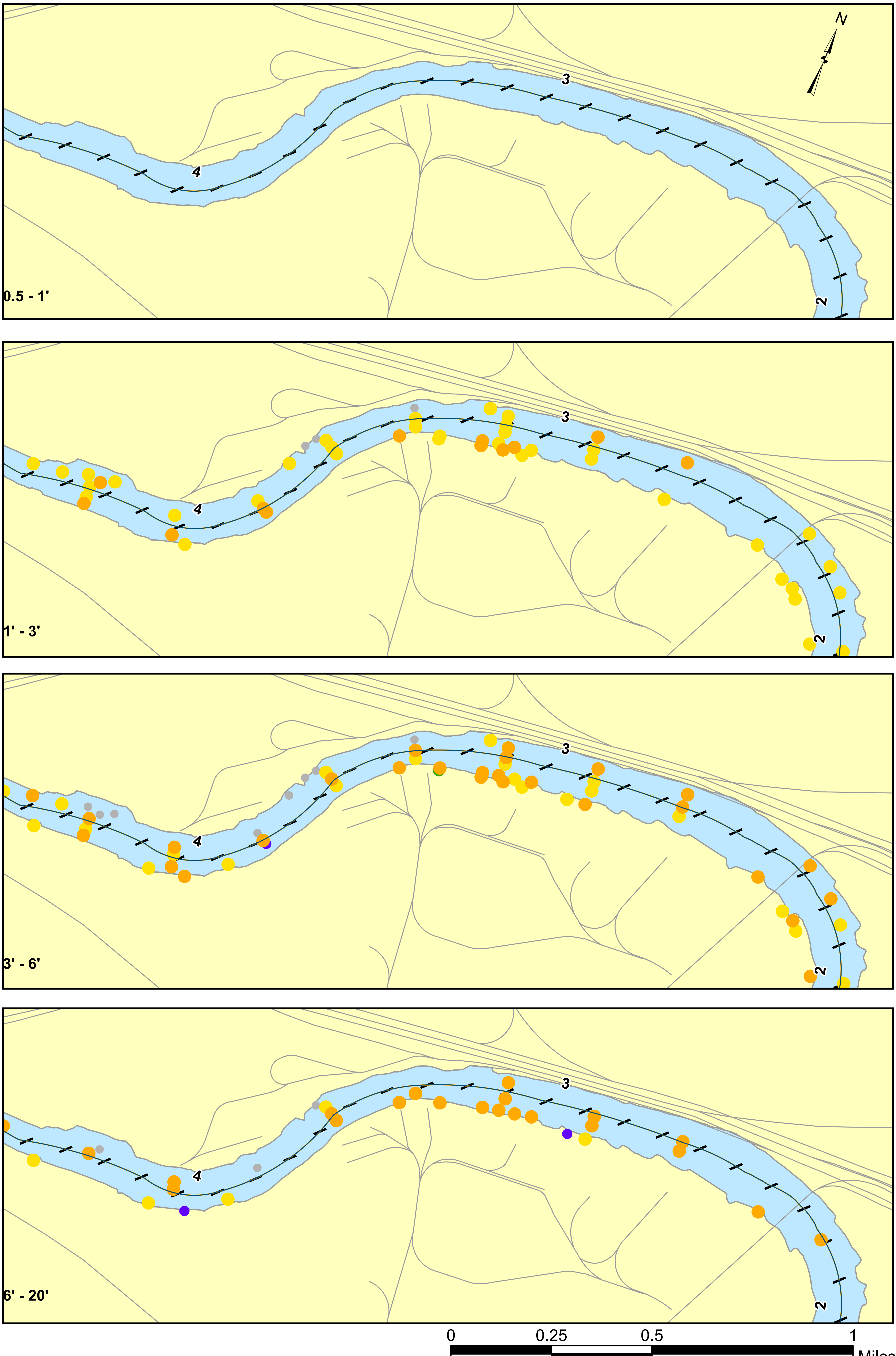
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-2



Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-3



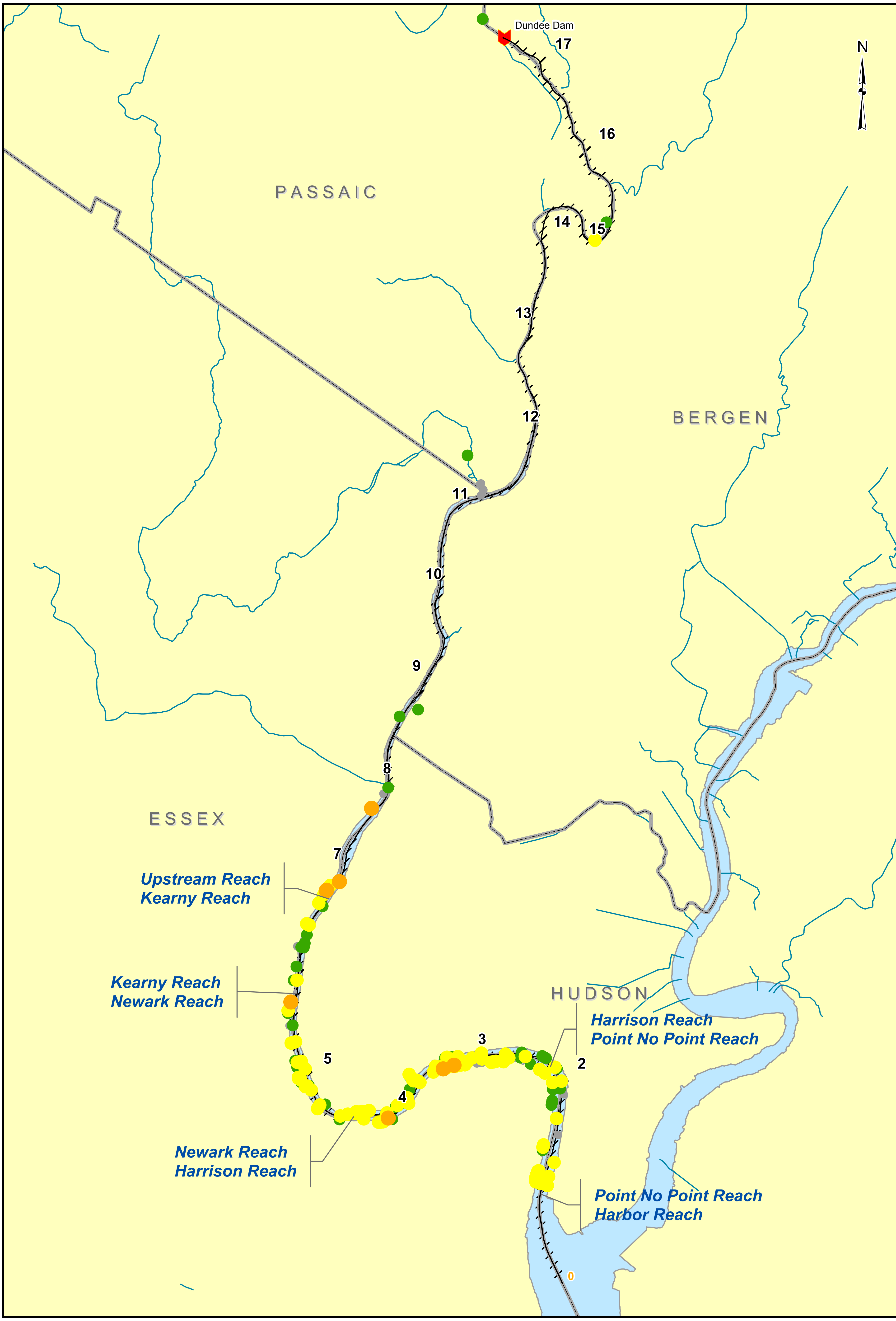
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-4



Mercury (PPB)

- 0 - 100
- 100 - 710
- 710 - 1,000
- 1,000 - 10,000
- 10,000 - 30,000

Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-5

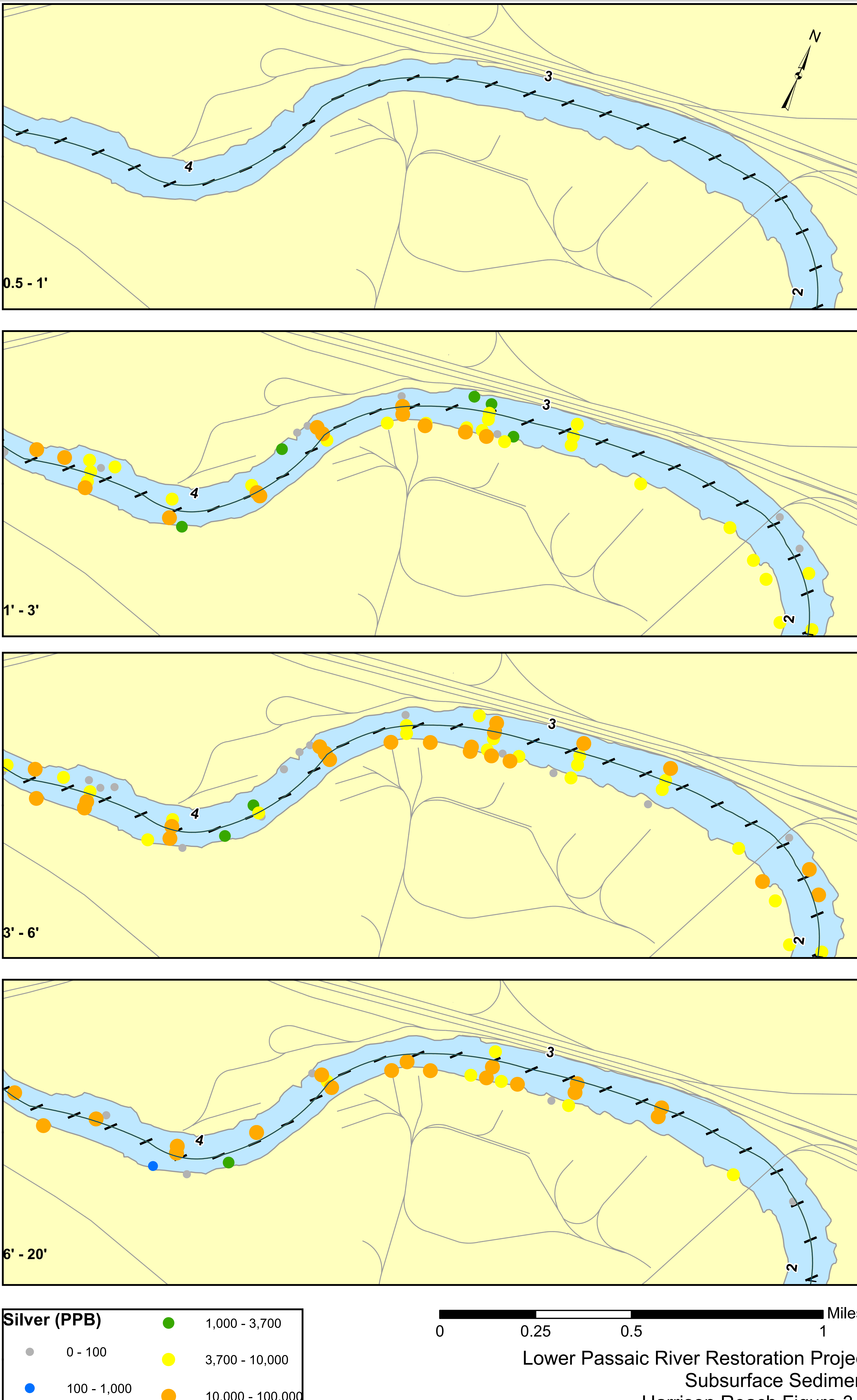


Silver (PPB)

- 0 - 100
- 101 - 1,000
- 1,001 - 3,700
- 3,701 - 10,000
- 10,001 - 100,000

0 0.5 1 2 Miles

Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-6



Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-7

Map Document: (S:\Projects\0285924\MapDocuments\0285924-CERCLA\MXD\HistoricalDataEvaluation\Surface_Metals_Arsenic.mxd)
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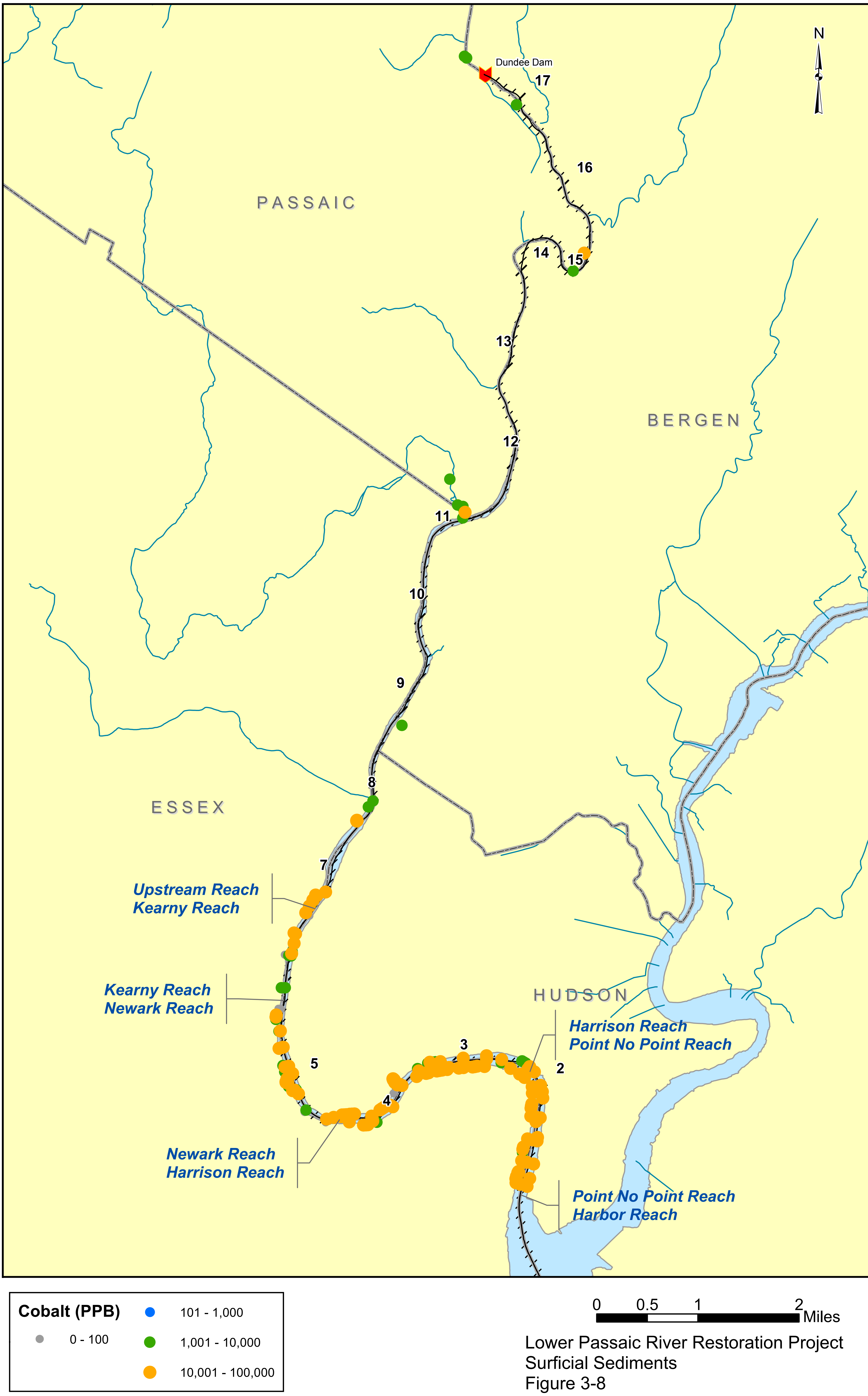
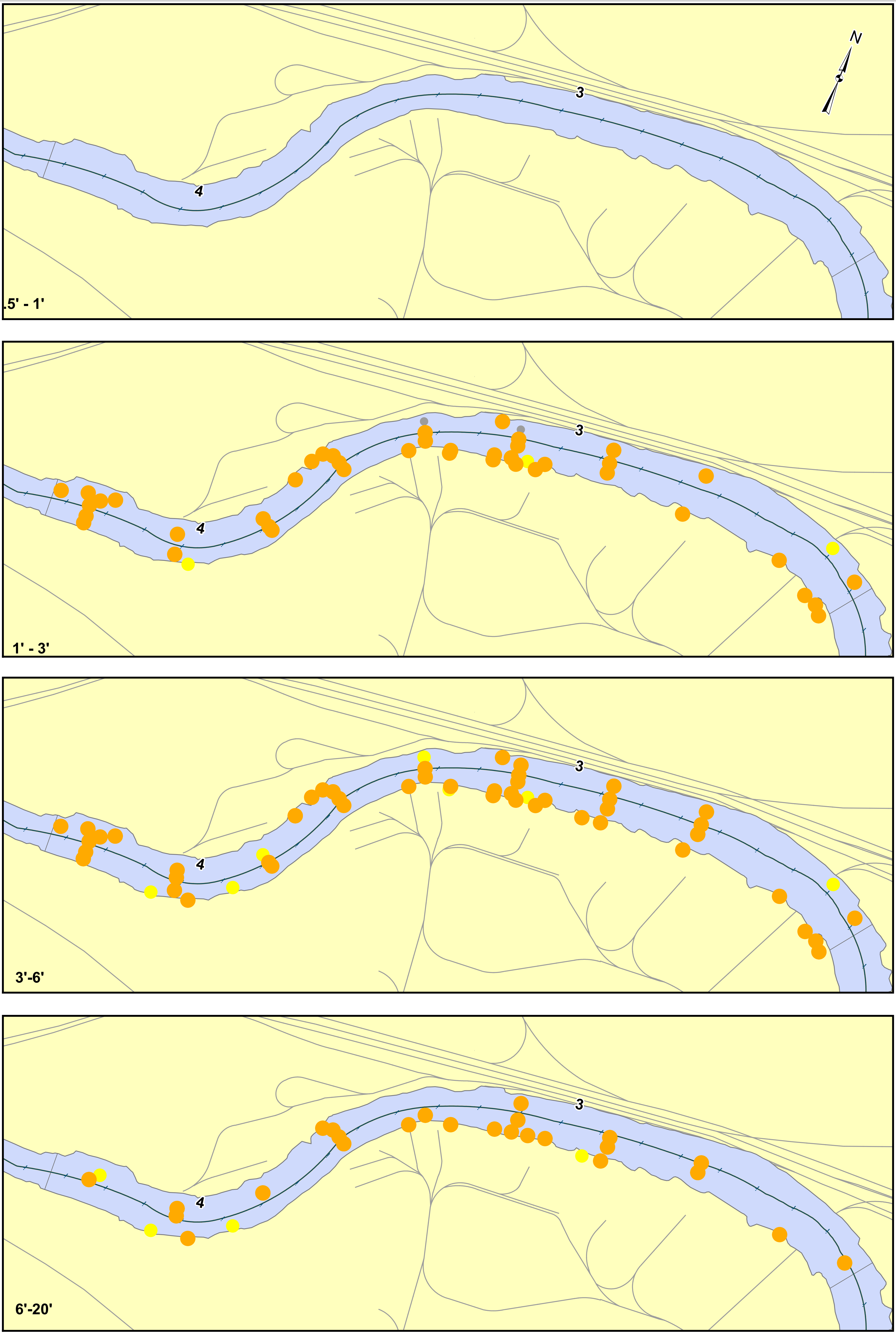


Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-8

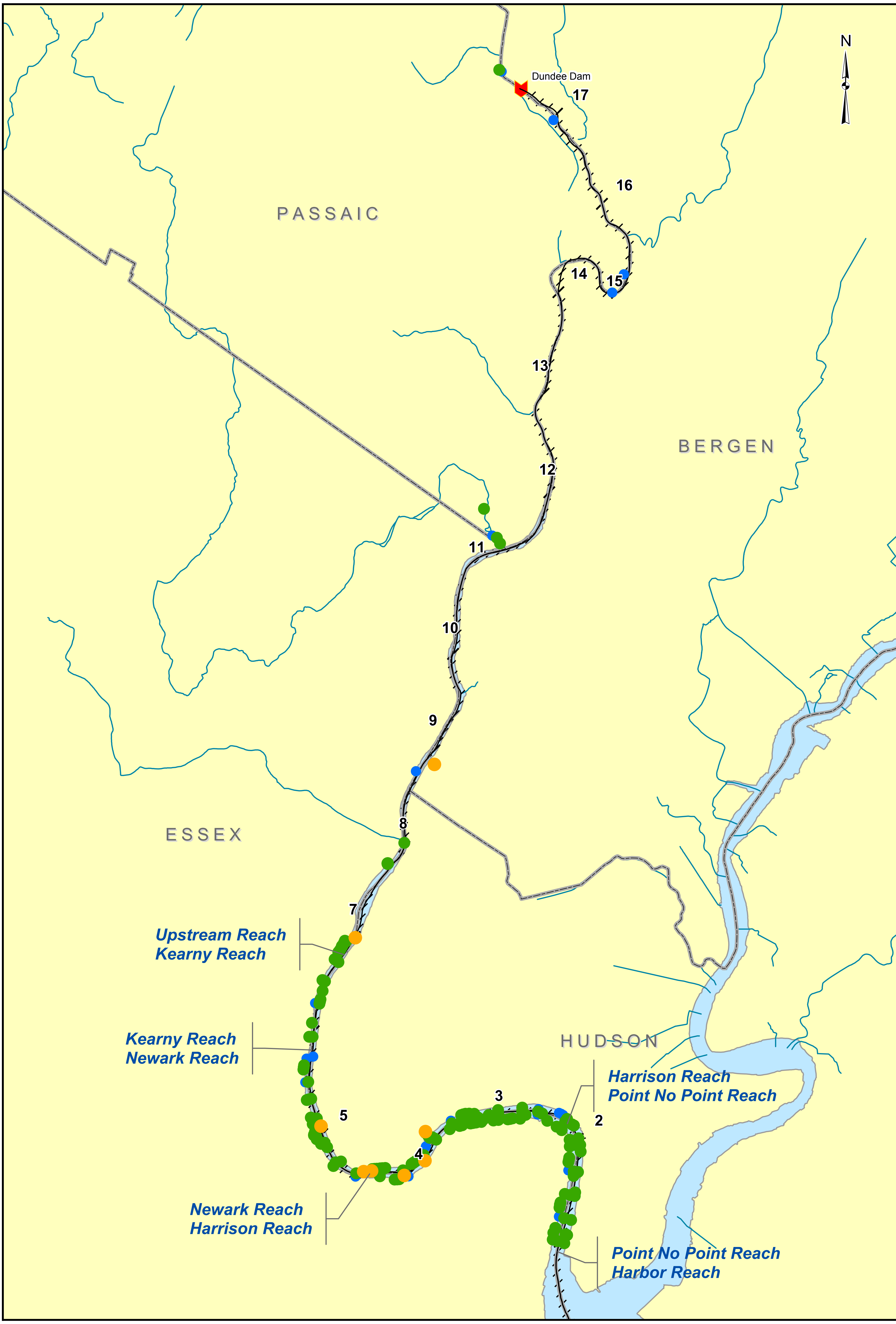


Cobalt (PPB)

- 0 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 100,000

0 0.25 0.5 1 Miles

Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-9

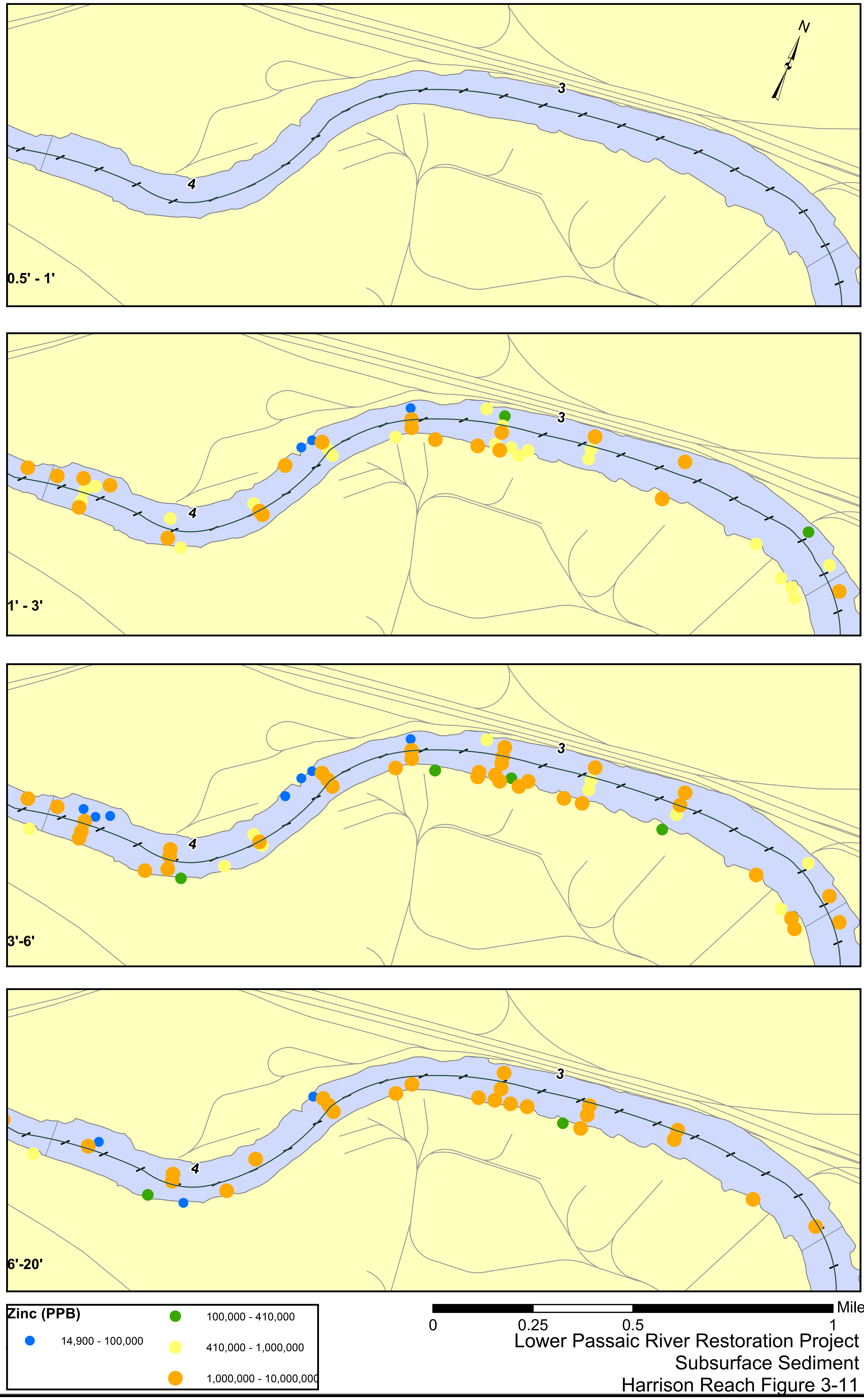


Zinc (PPB)

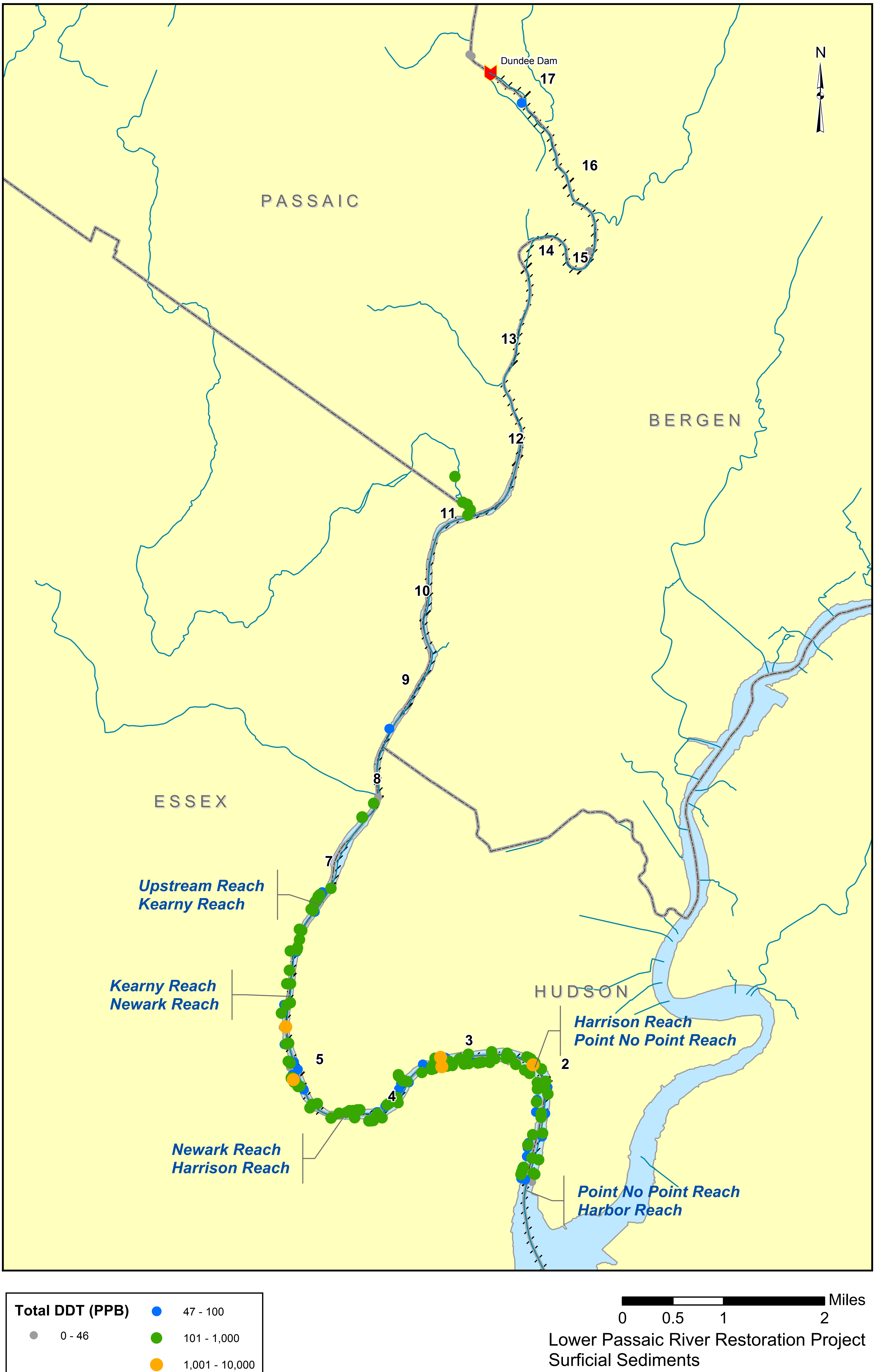
- 1 - 100,000
- 100,001 - 410,000
- 410,001 - 1,000,000
- 1,000,001 - 10,000,000

Miles: 0, 0.5, 1, 2

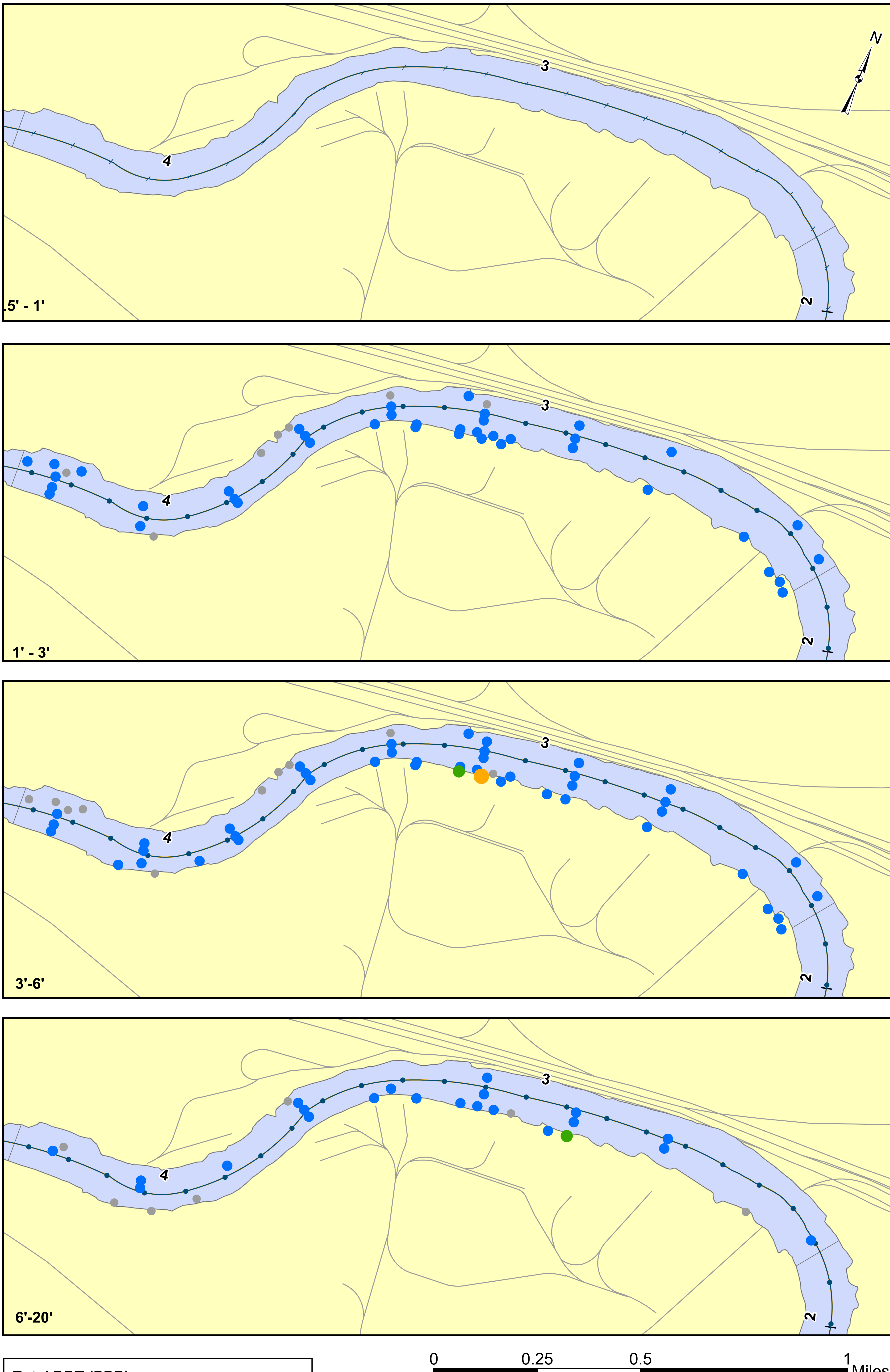
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-10



Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-11



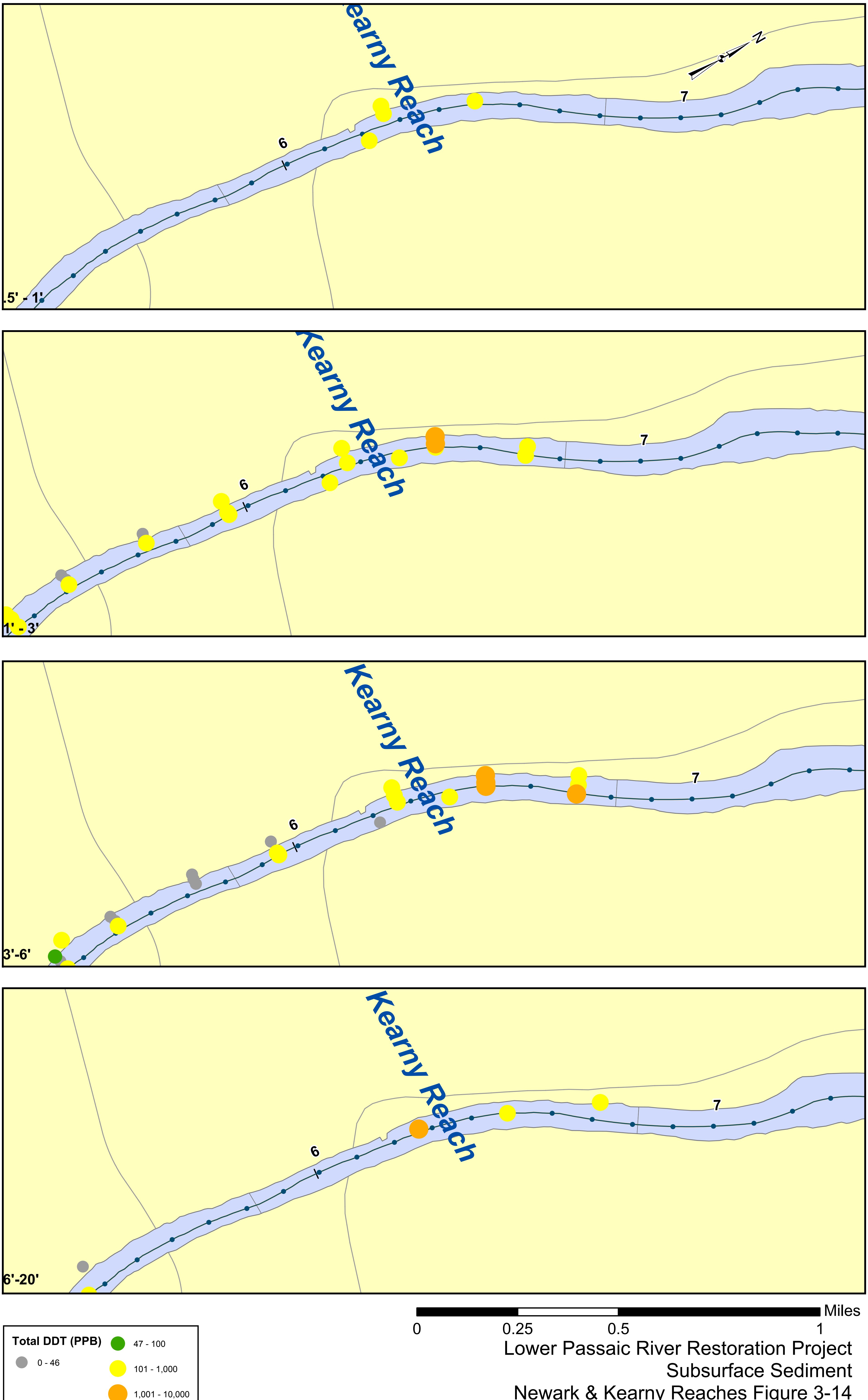
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-12



Total DDT (PPB)

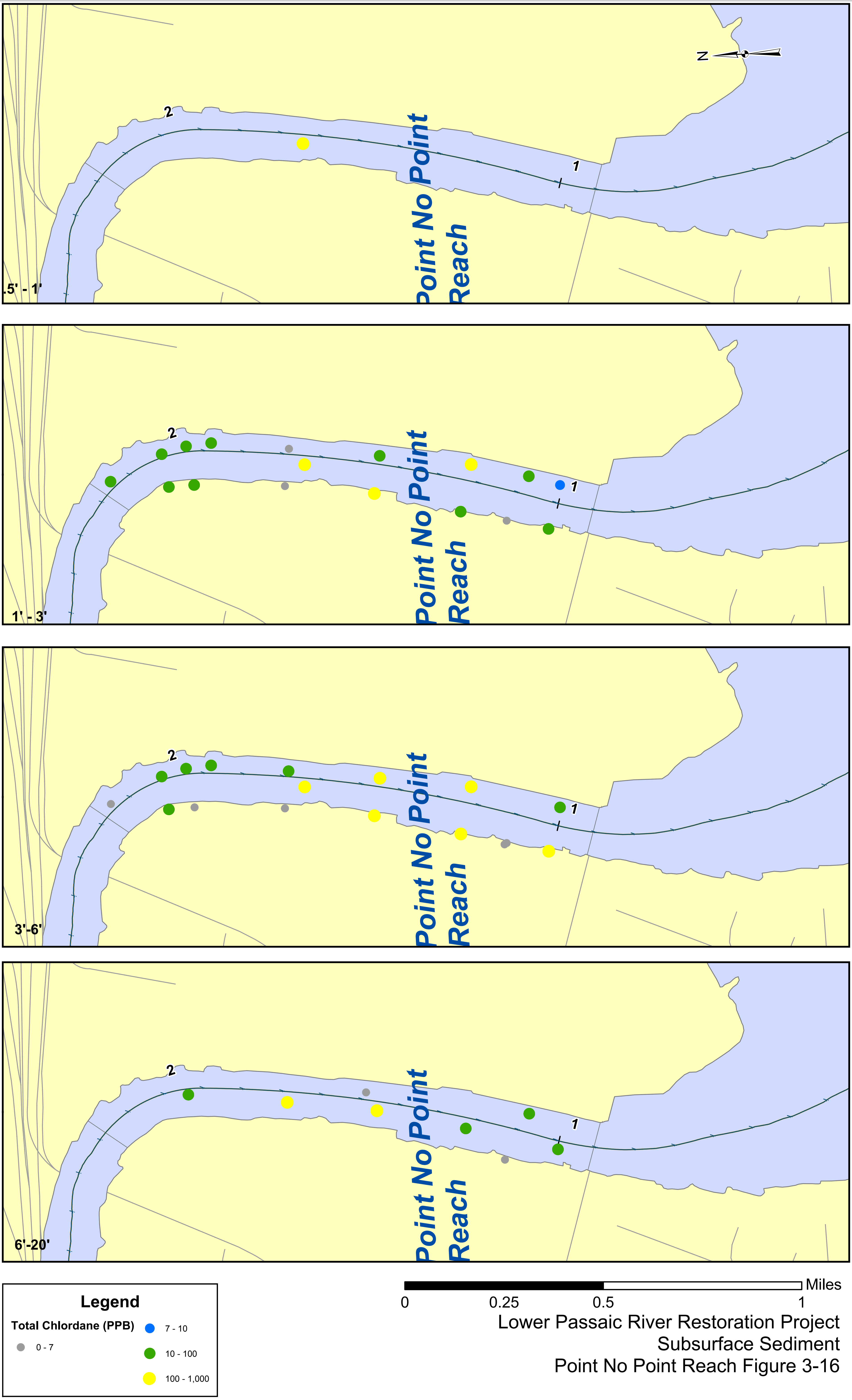
- 0 - 46
- 46 - 100,000
- 100,000 - 1,000,000
- 1,000,000 - 10,000,000
- 10,000,000 - 100,000,000

Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-13



Lower Passaic River Restoration Project
Subsurface Sediment
Newark & Kearny Reaches Figure 3-14

Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-15



Lower Passaic River Restoration Project
Subsurface Sediment
Point No Point Reach Figure 3-16

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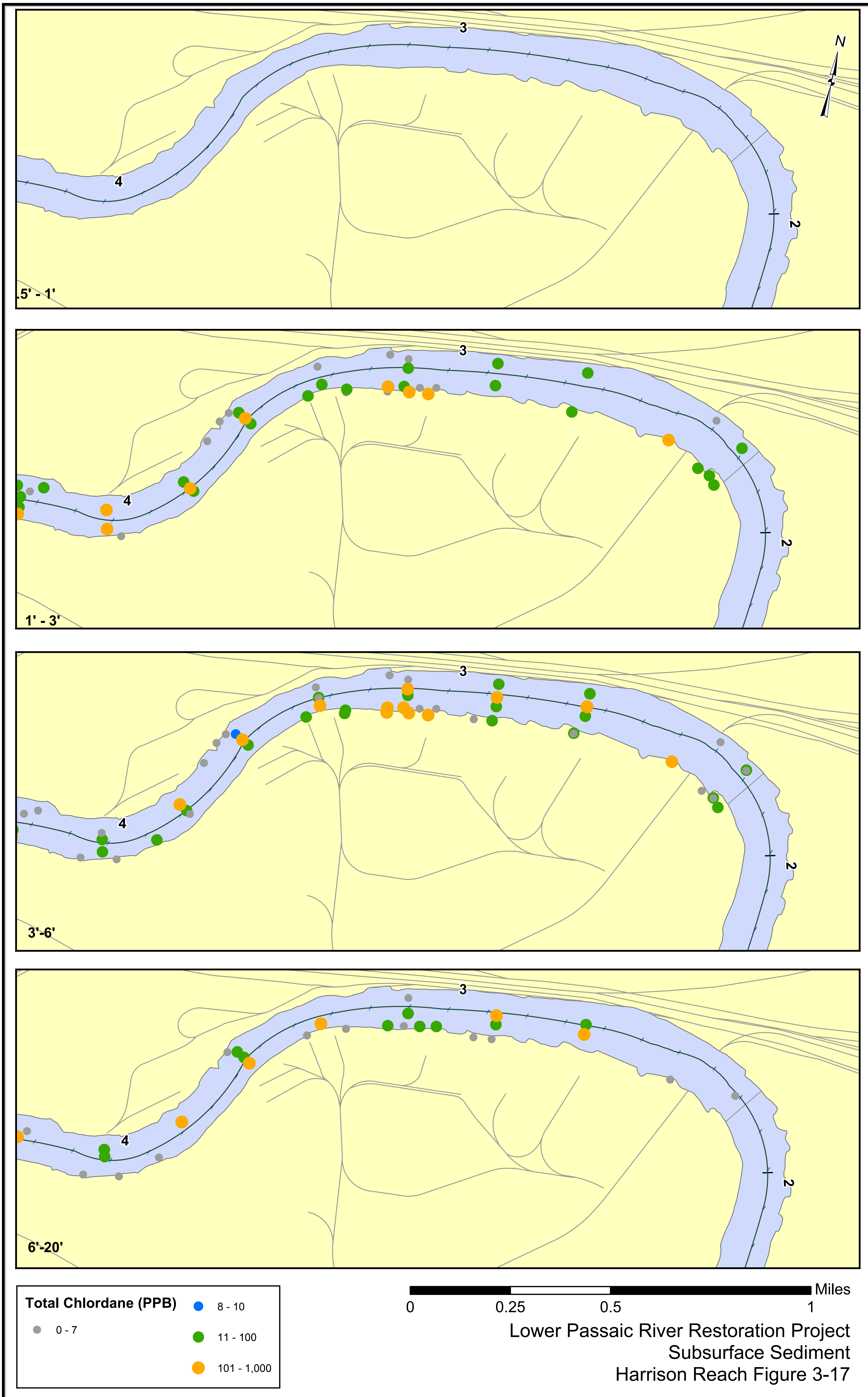
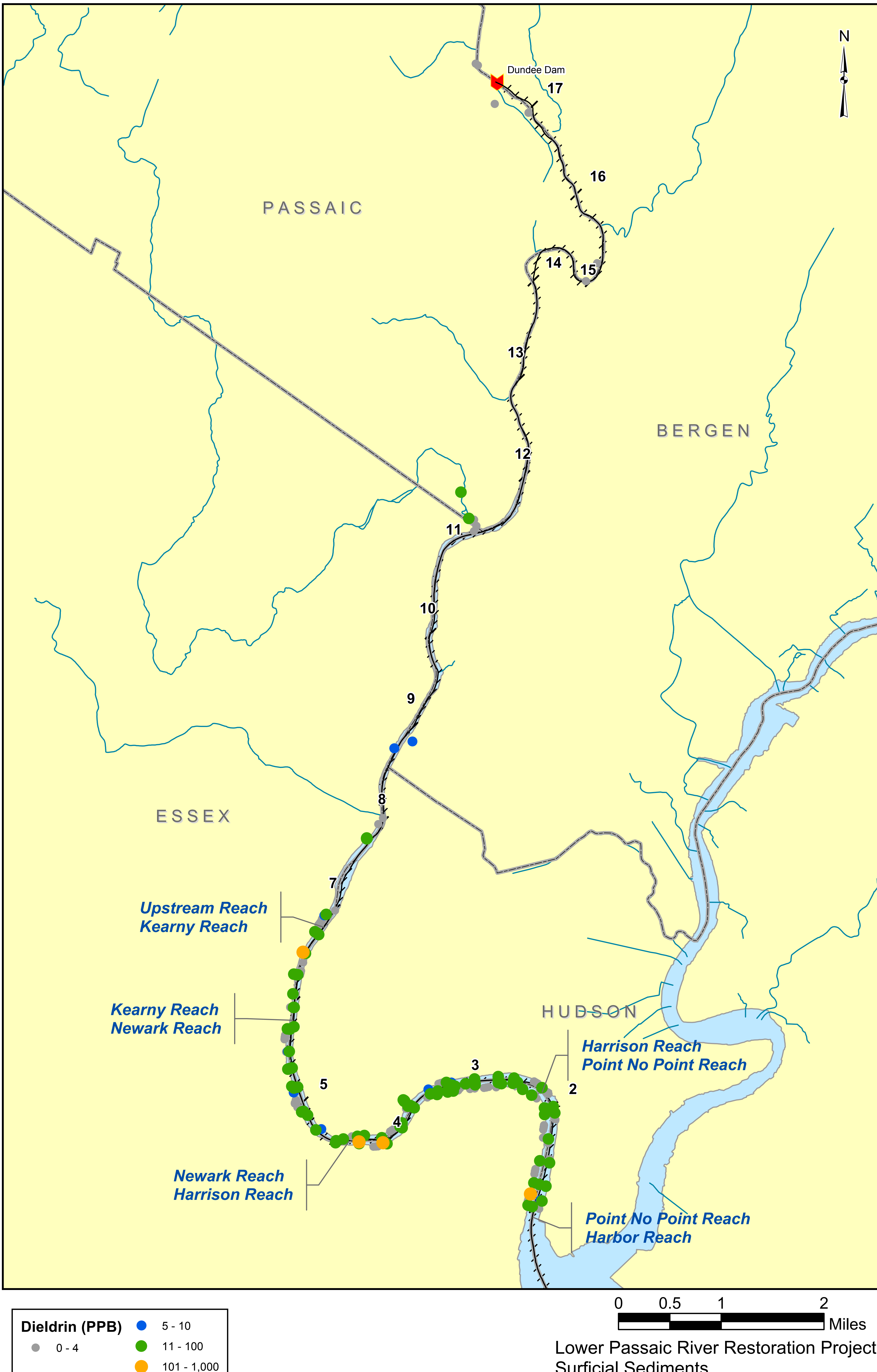
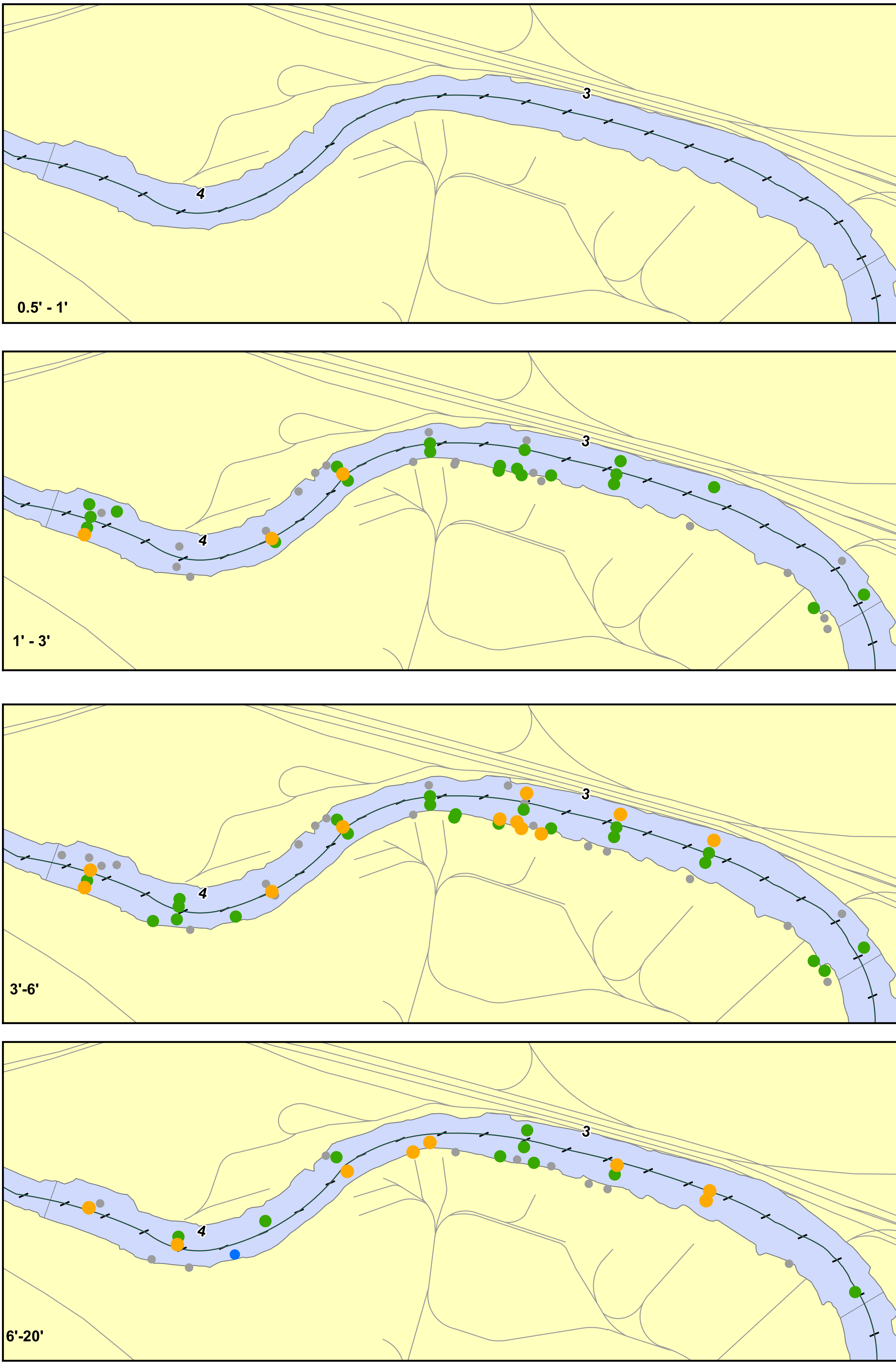


Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-17



Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-18

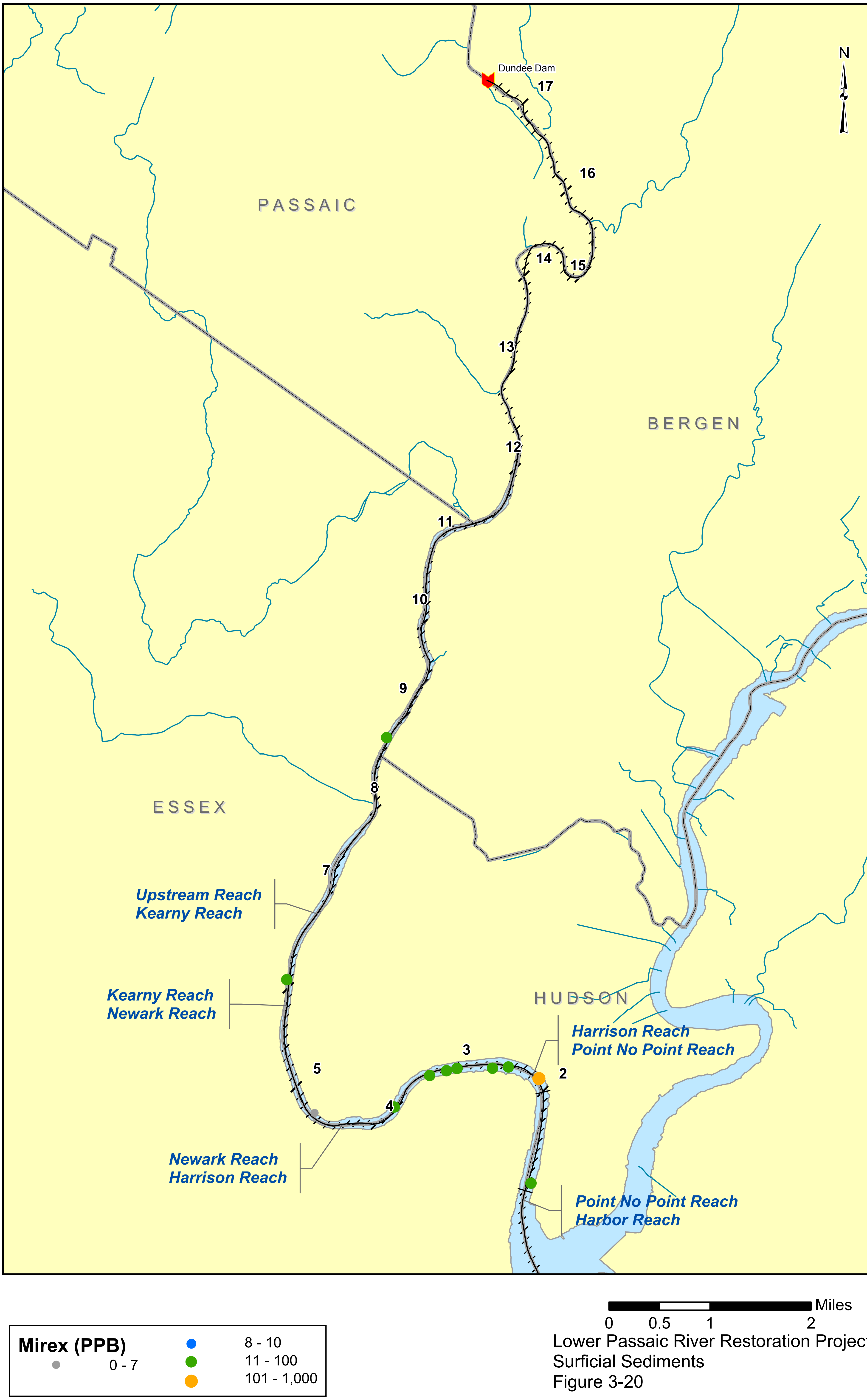


Dieldrin (PPB)

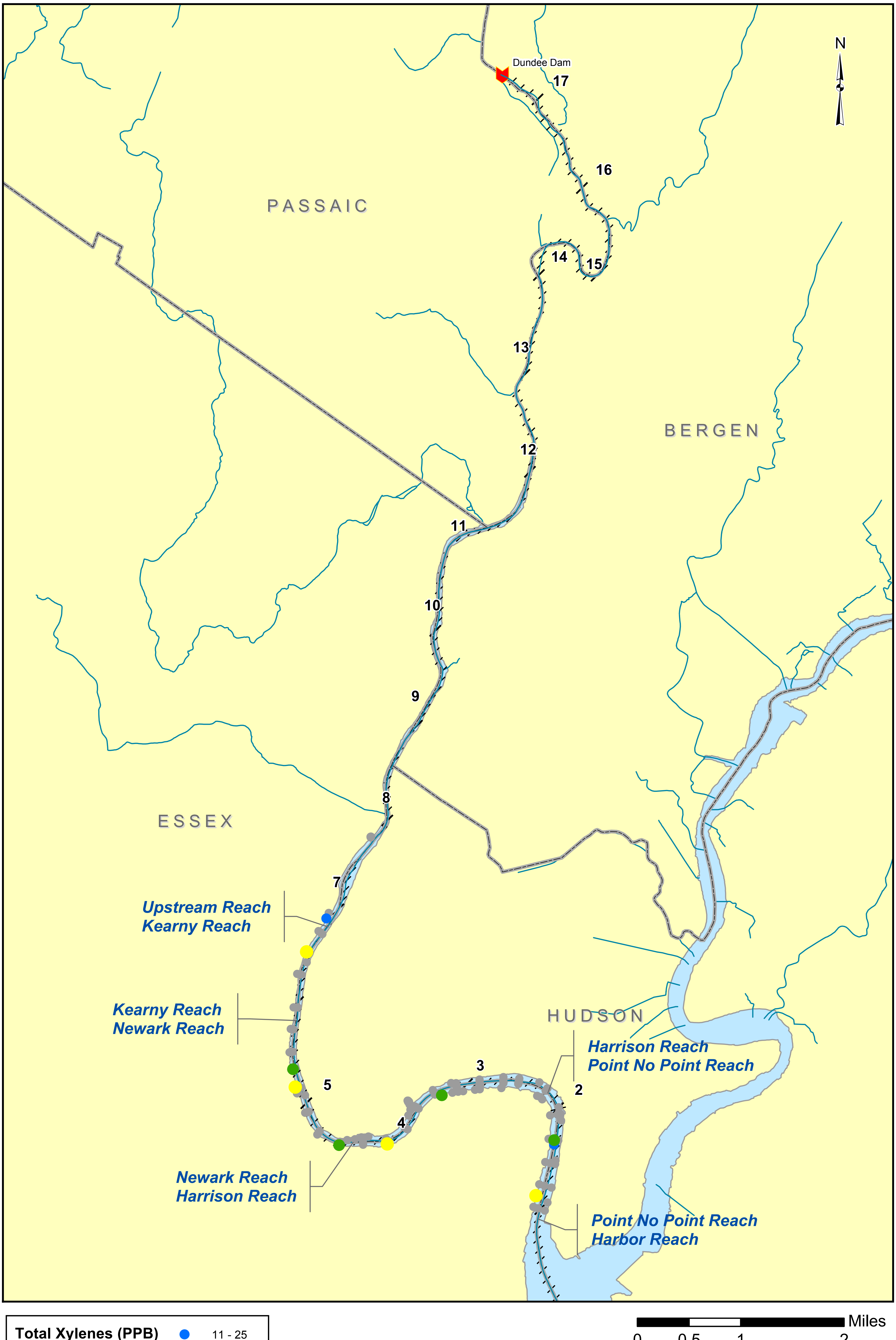
- 0 - 4
- 5 - 10
- 11 - 100
- 101 - 1,000

Miles: 0 | 0.25 | 0.5 | 1

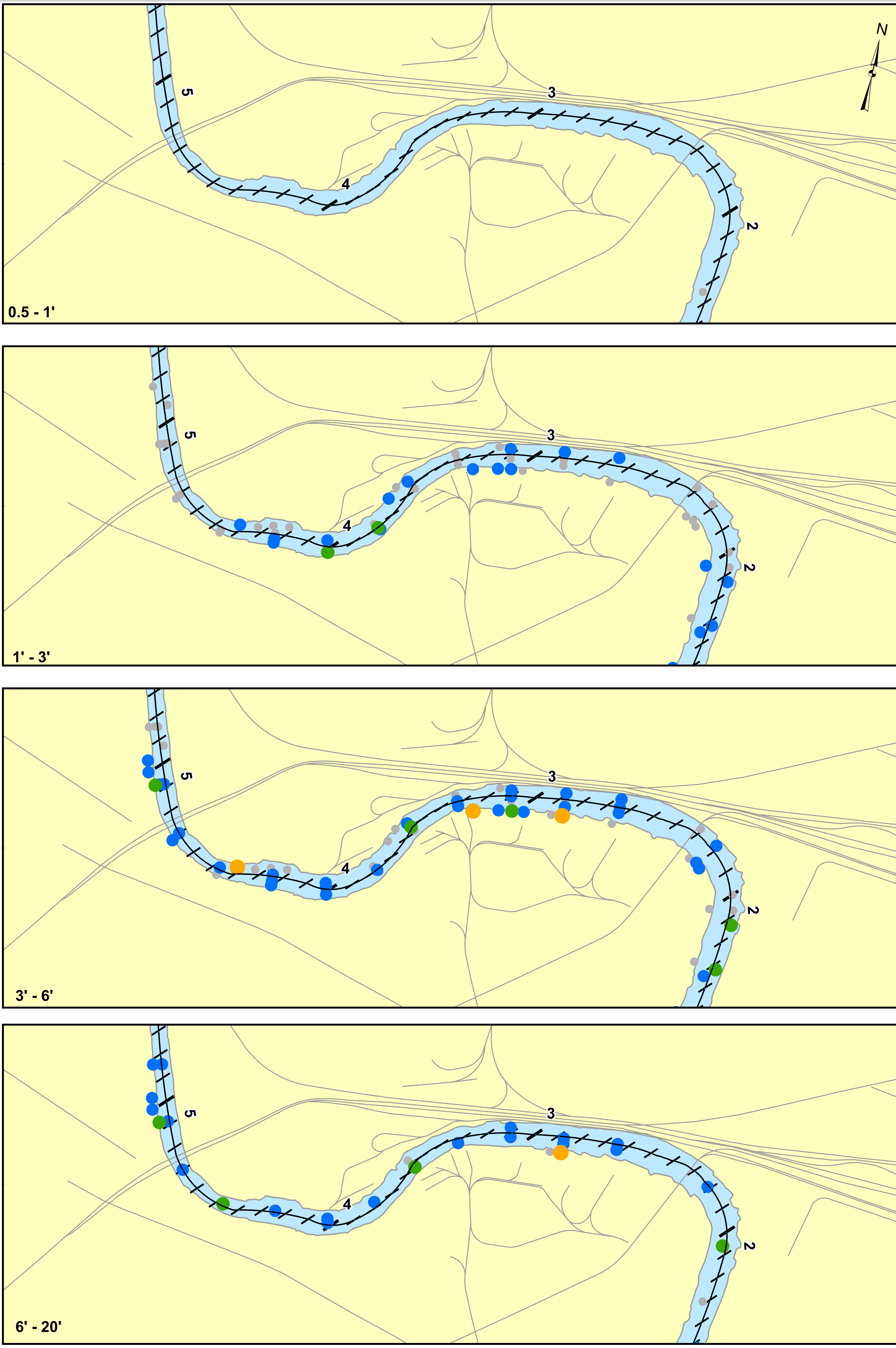
Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-19



Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-20



Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-21

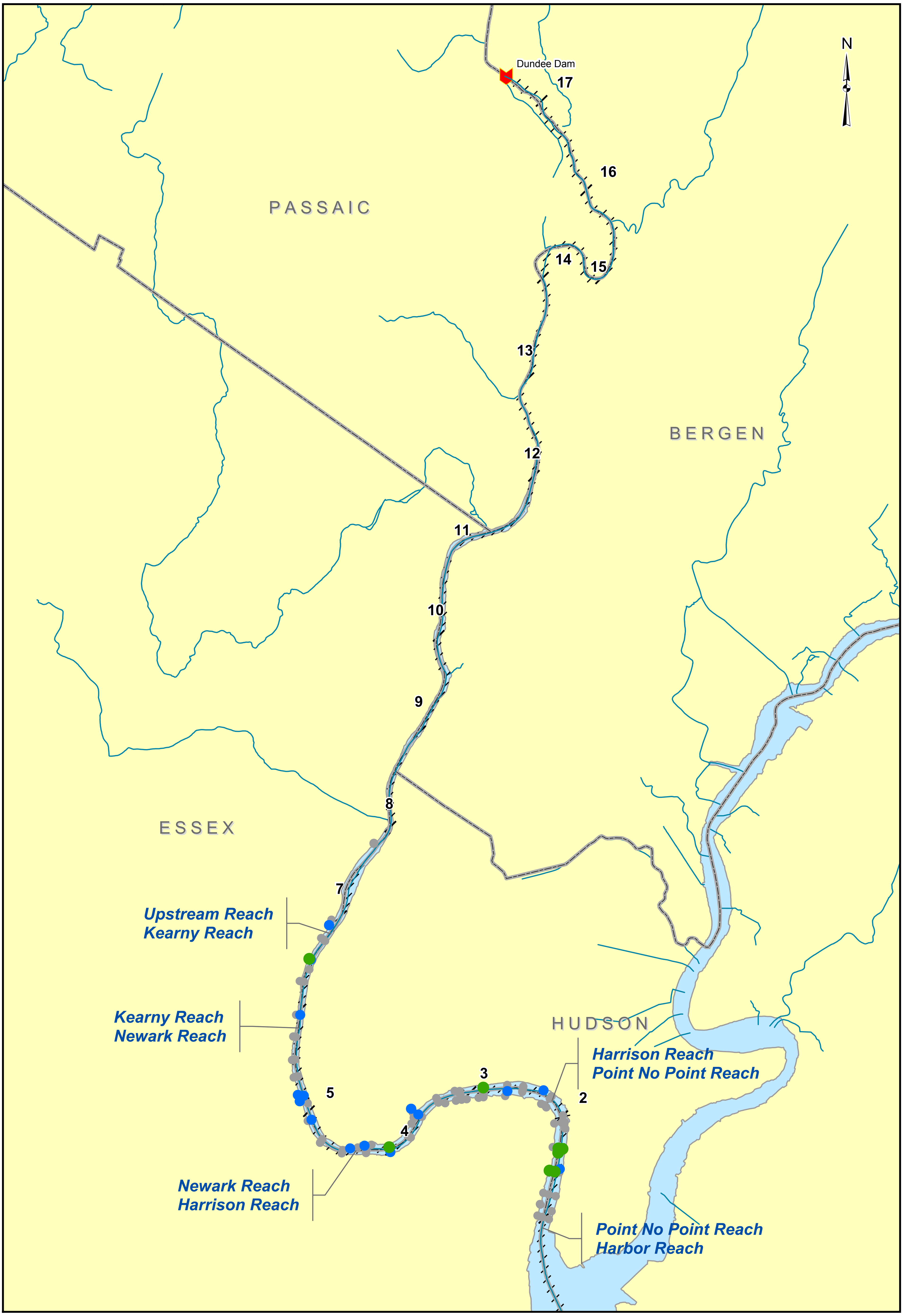


Total Xylenes (PPB)

- 0 - 25
- 26 - 433
- 434 - 4,330
- 4,331 - 44,000

Miles
0 0.25 0.5 1

Lower Passaic River Restoration Project
Subsurface Sediment
River Miles 1.5 - 5.3 Figure 3-22

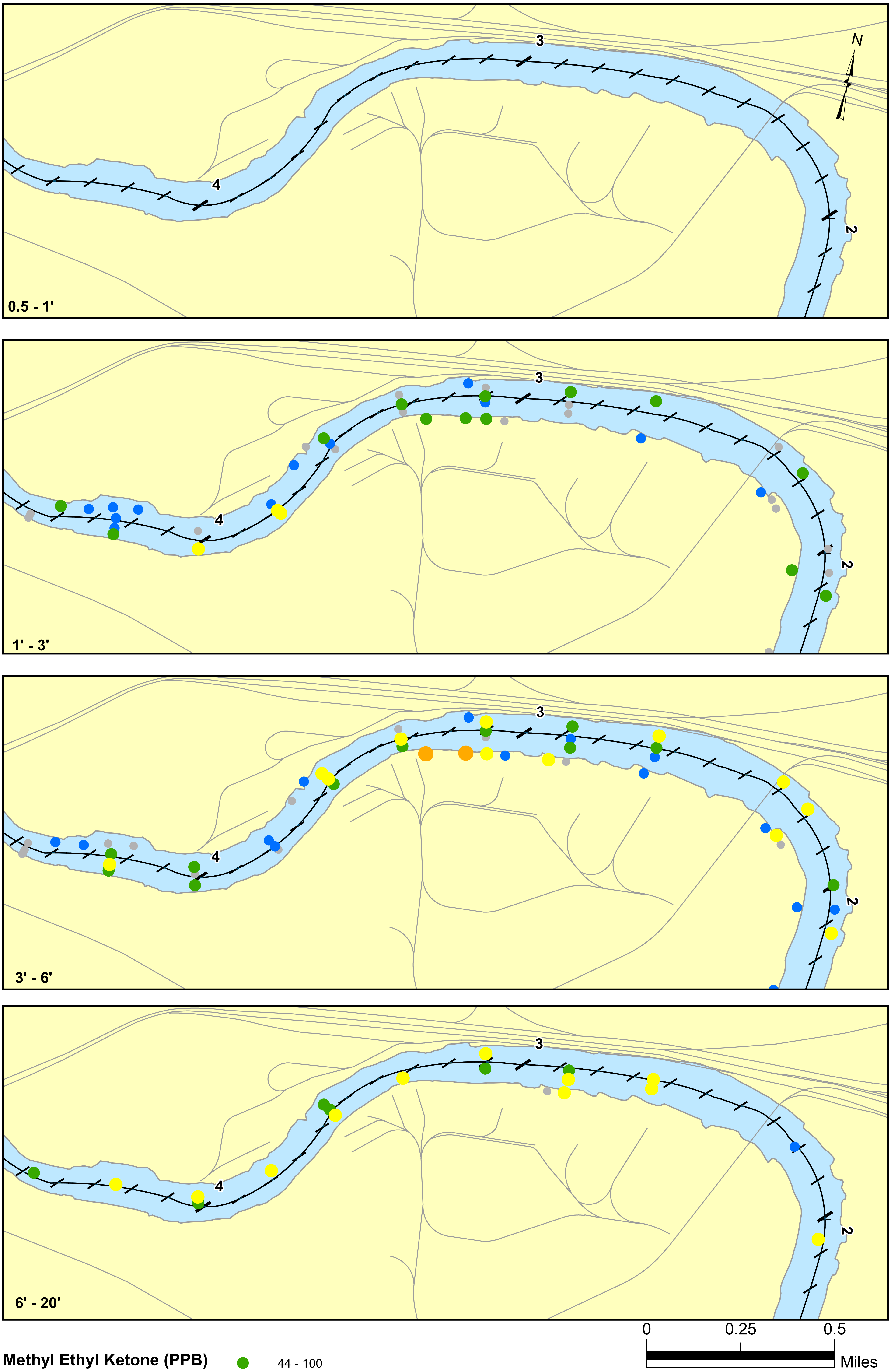


Methyl Ethyl Ketone (PPB)

- 0 - 10
- 11 - 43
- 44 - 100

0 0.5 1 2 Miles

Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-23



Methyl Ethyl Ketone (PPB)

- 0 - 10
- 11 - 43
- 44 - 100
- 101 - 1,000
- 1,001 - 10,000

Lower Passaic River Restoration Project
Subsurface Sediment
River Miles 1.75 - 4.5 Figure 3-24

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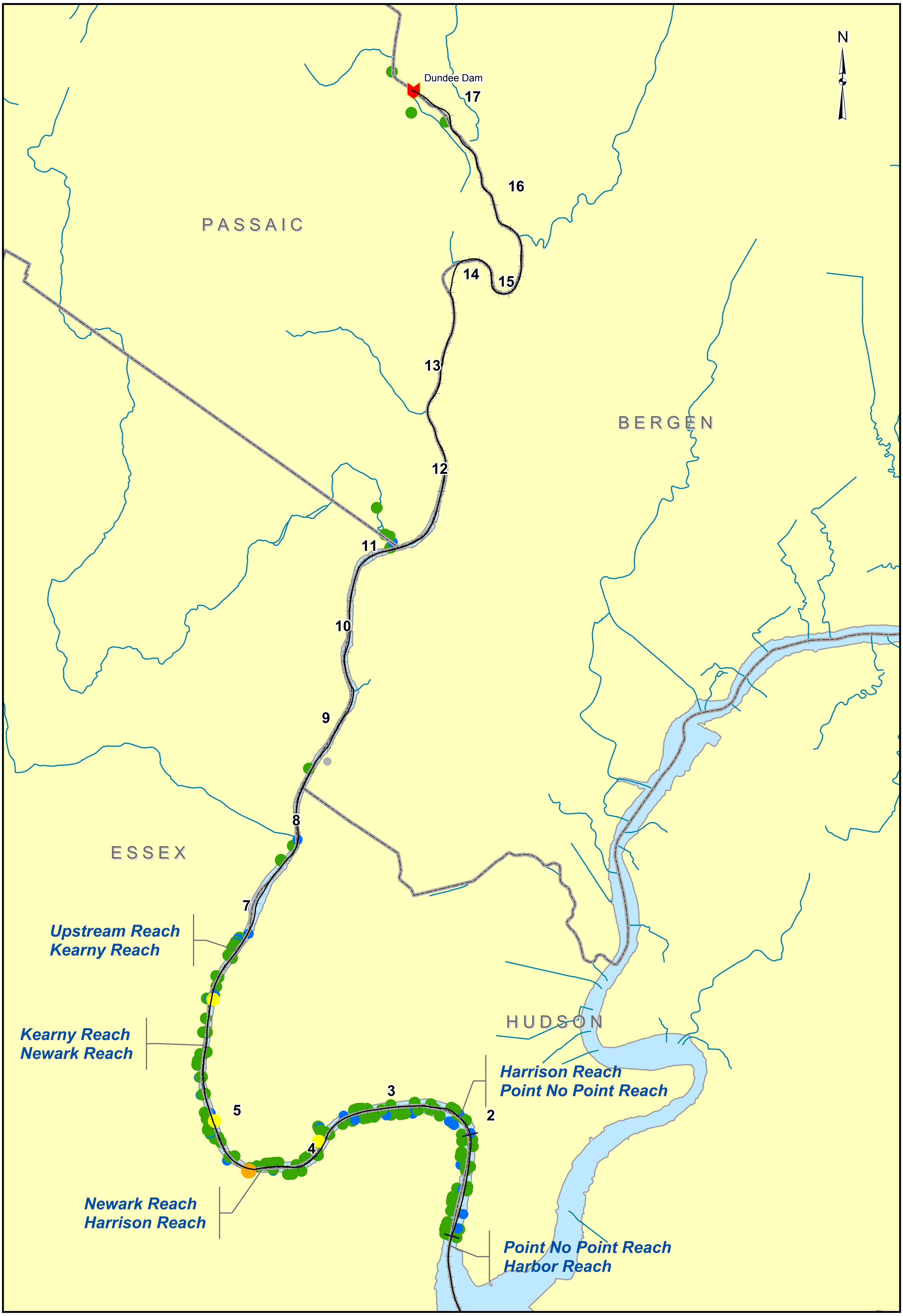
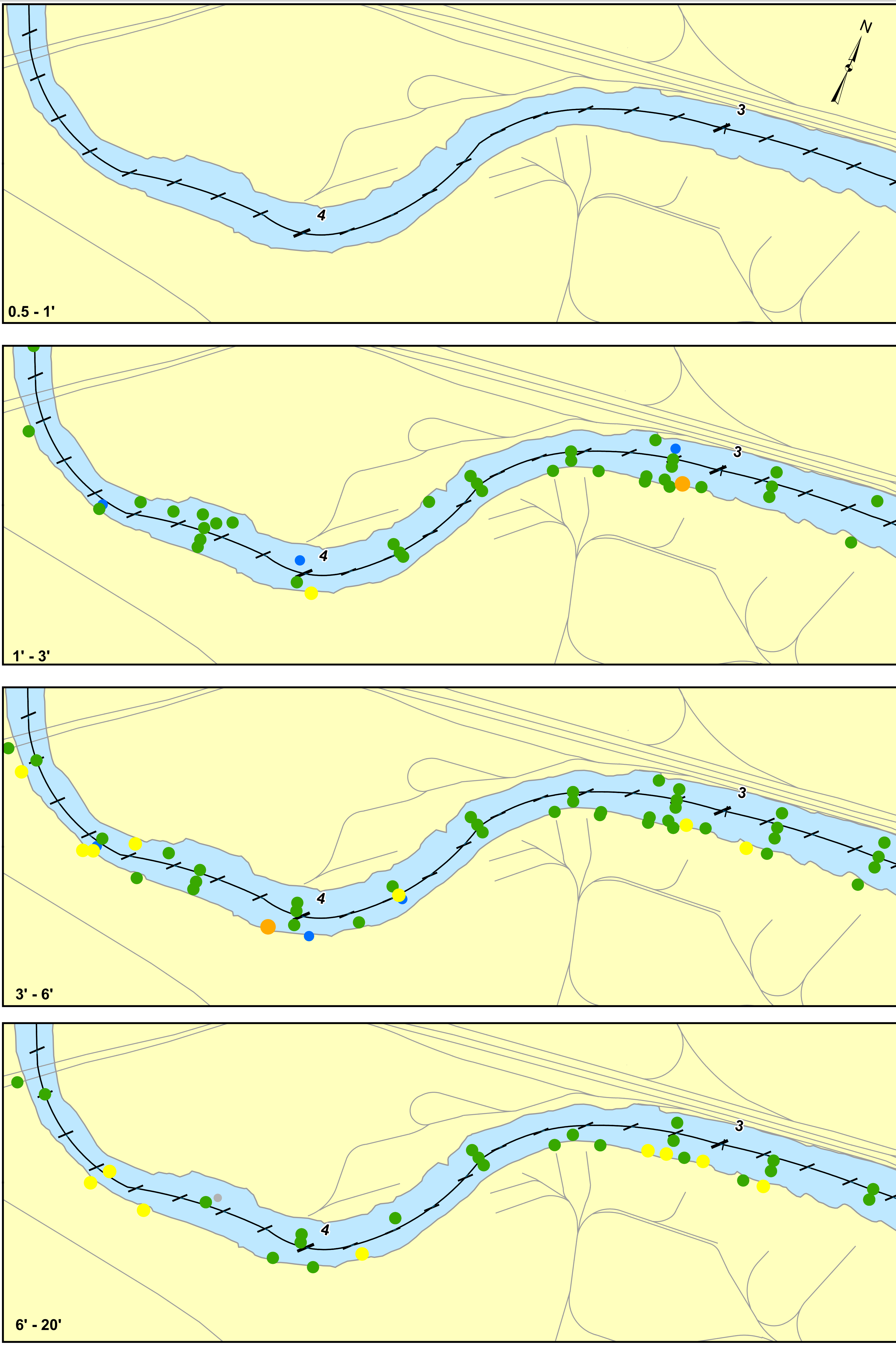


Total High Molecular Weight PAHs (PPB)

- 0 - 1,000
- 1,000 - 10,000
- 10,000 - 100,000
- 100,000 - 1,000,000
- 1,000,000 - 10,000,000

Miles
0 0.5 1 2

Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-25

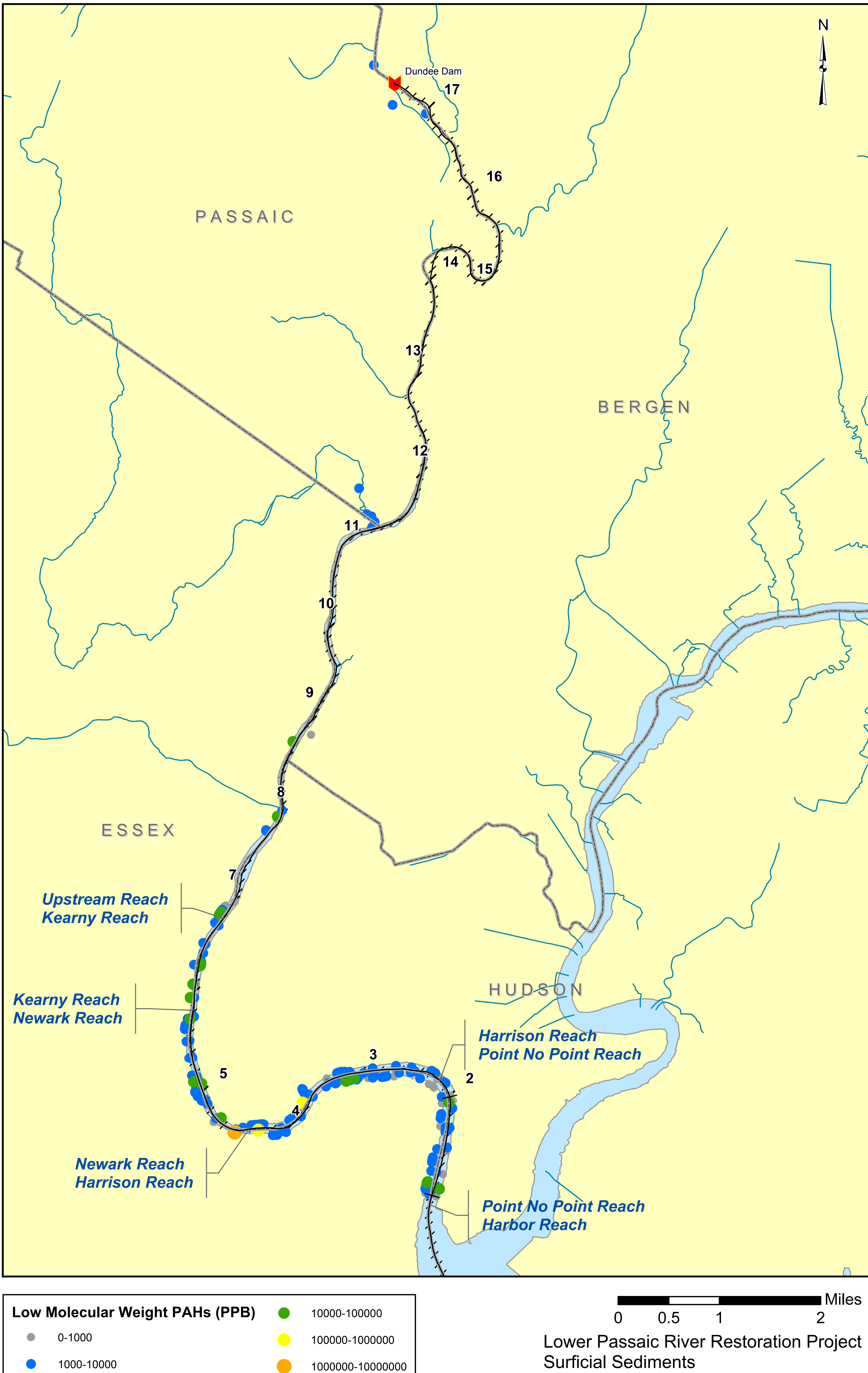


0 0.25 0.5 1 Miles

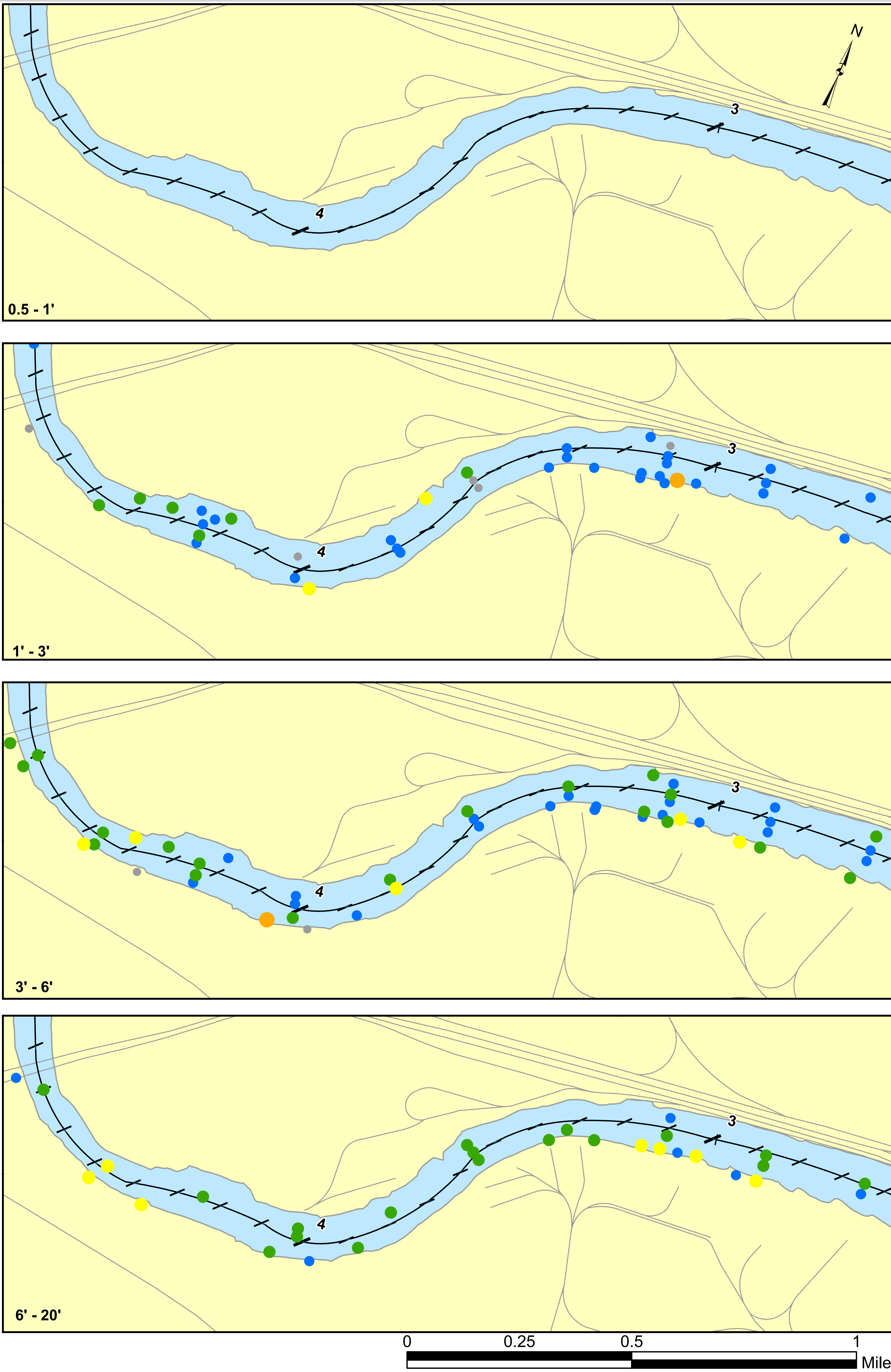
High Molecular Weight PAHs (PPB)

- 220 - 1,000
- 1,001 - 10,000
- 10,001 - 100,000
- 100,001 - 1,000,000
- 1,000,001 - 10,000,000

Lower Passaic River Restoration Project
Subsurface Sediment
River Miles 2.6 - 4.8 Figure 3-26



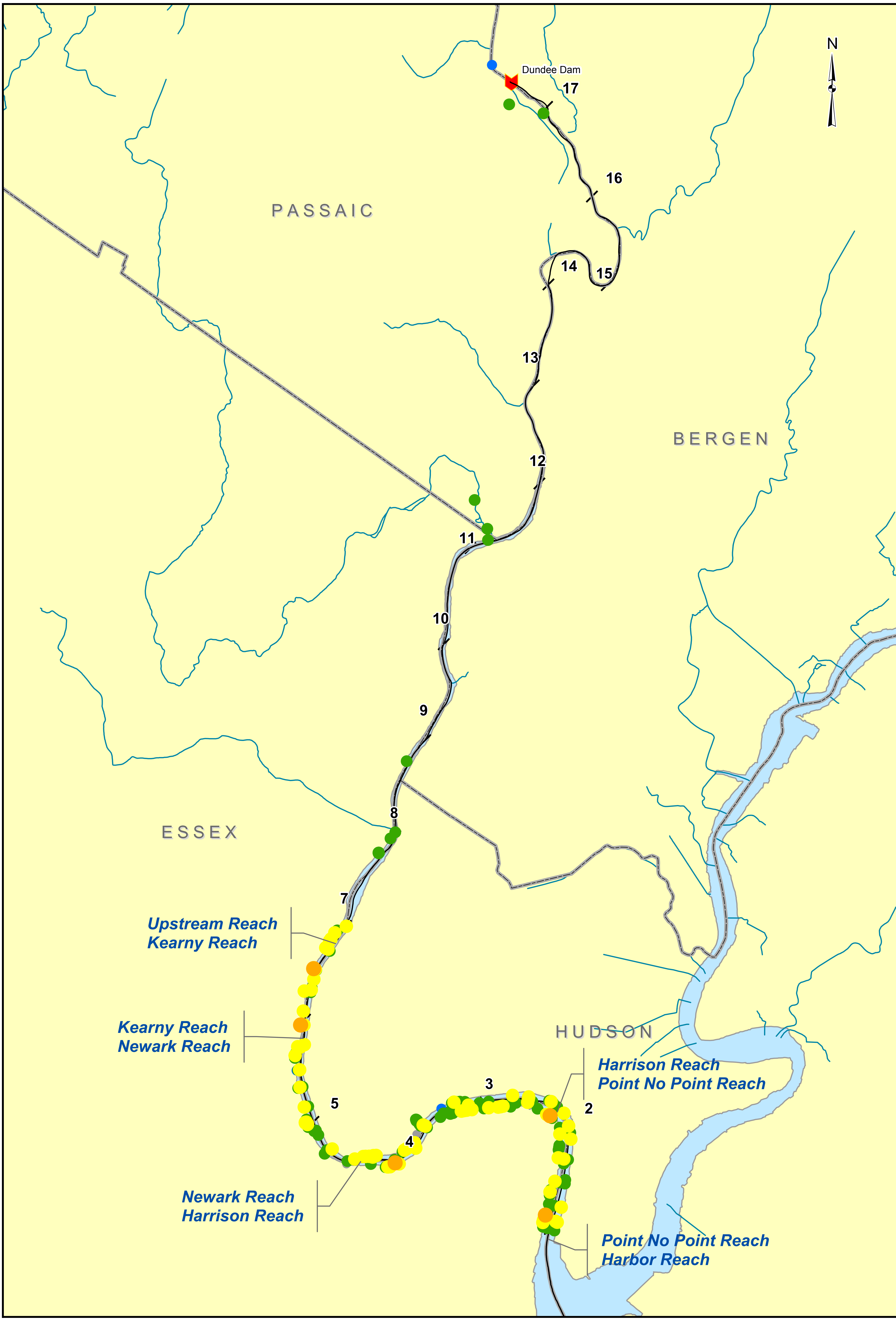
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-27



Low Molecular Weight PAHs (PPB)

- 180 - 1,000
- 1,001 - 10,000
- 10,001 - 100,000
- 100,001 - 1,000,000
- 1,000,001 - 10,000,000

Lower Passaic River Restoration Project
Subsurface Sediment
River Miles 2.6 - 4.8 Figure 3-28



Total PCBs (PPB)

- 2 - 100
- 101 - 180
- 181 - 1,000
- 1,001 - 5,000
- 5,001 - 17,200

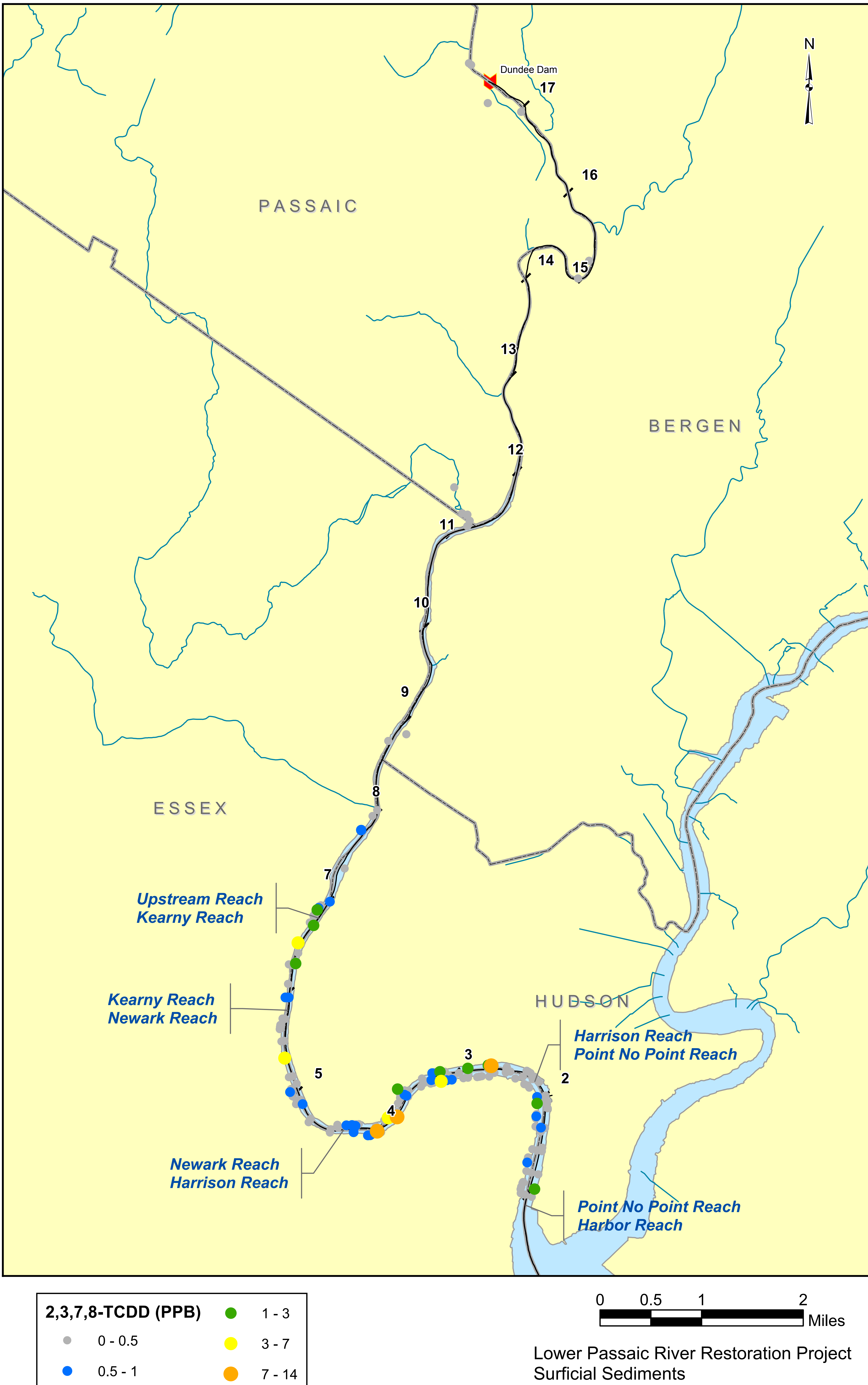
Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-29

0 0.25 0.5 1
Miles

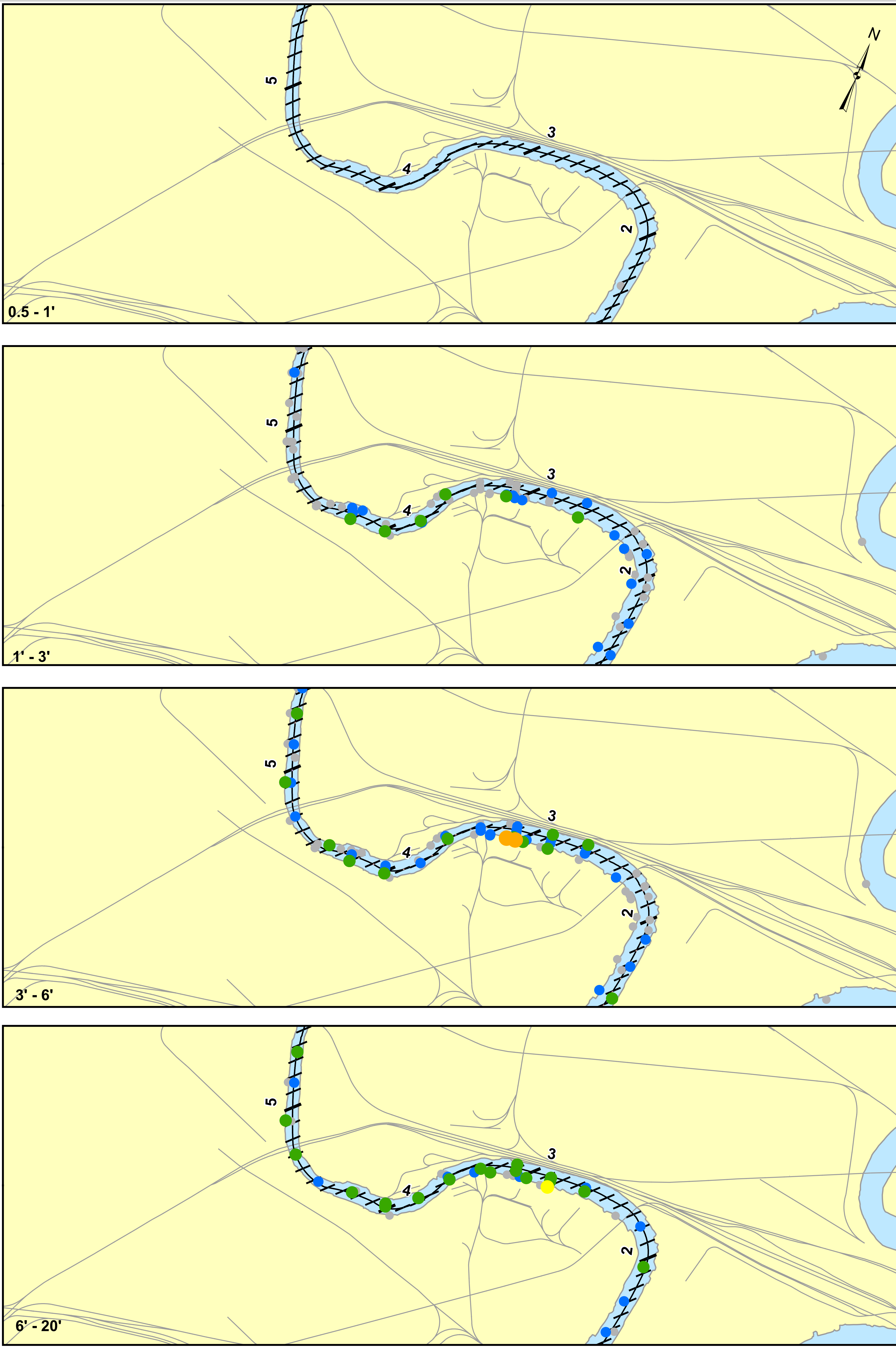
Total PCBs (PPB)

- 0 - 100
- 101 - 180
- 181 - 1,000
- 1,001 - 5,000
- 5,001 - 47,700

Lower Passaic River Restoration Project
Subsurface Sediment
Point No Point, Harrison, and Newark Reaches Figure 3-30



Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-31



2,3,7,8-TCDD (PPB)

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 5,300

0 0.25 0.5 1 Miles

Lower Passaic River Restoration Project
Subsurface Sediment
Point No Point, Harrison, and Newark Reaches Figure 3-32

Map Document: (S:\Projects\0285924\MapDocuments\0285924-CERCLA\MXD\HistoricalDataEvaluation\Surface_Metals_Arsenic.mxd)
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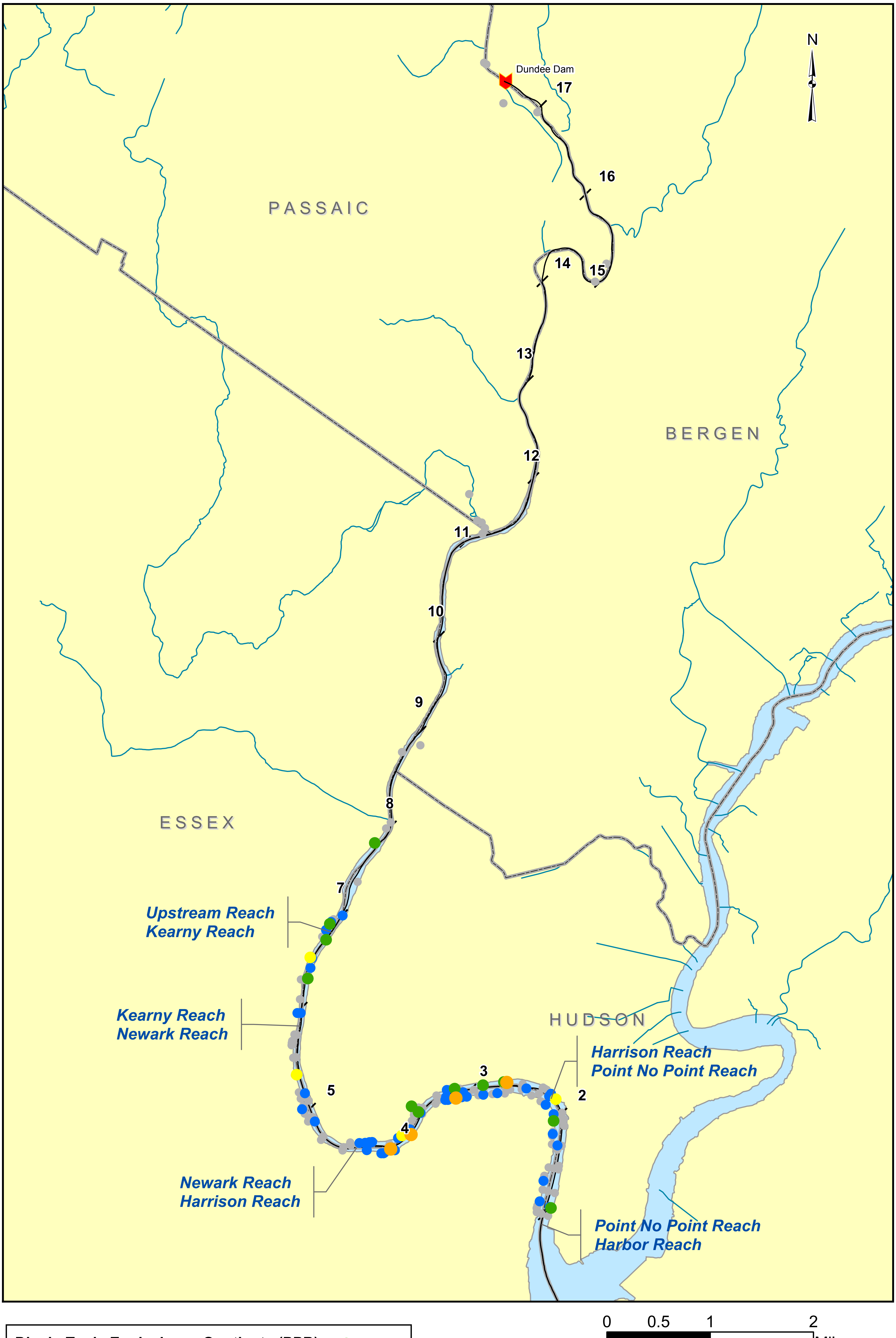
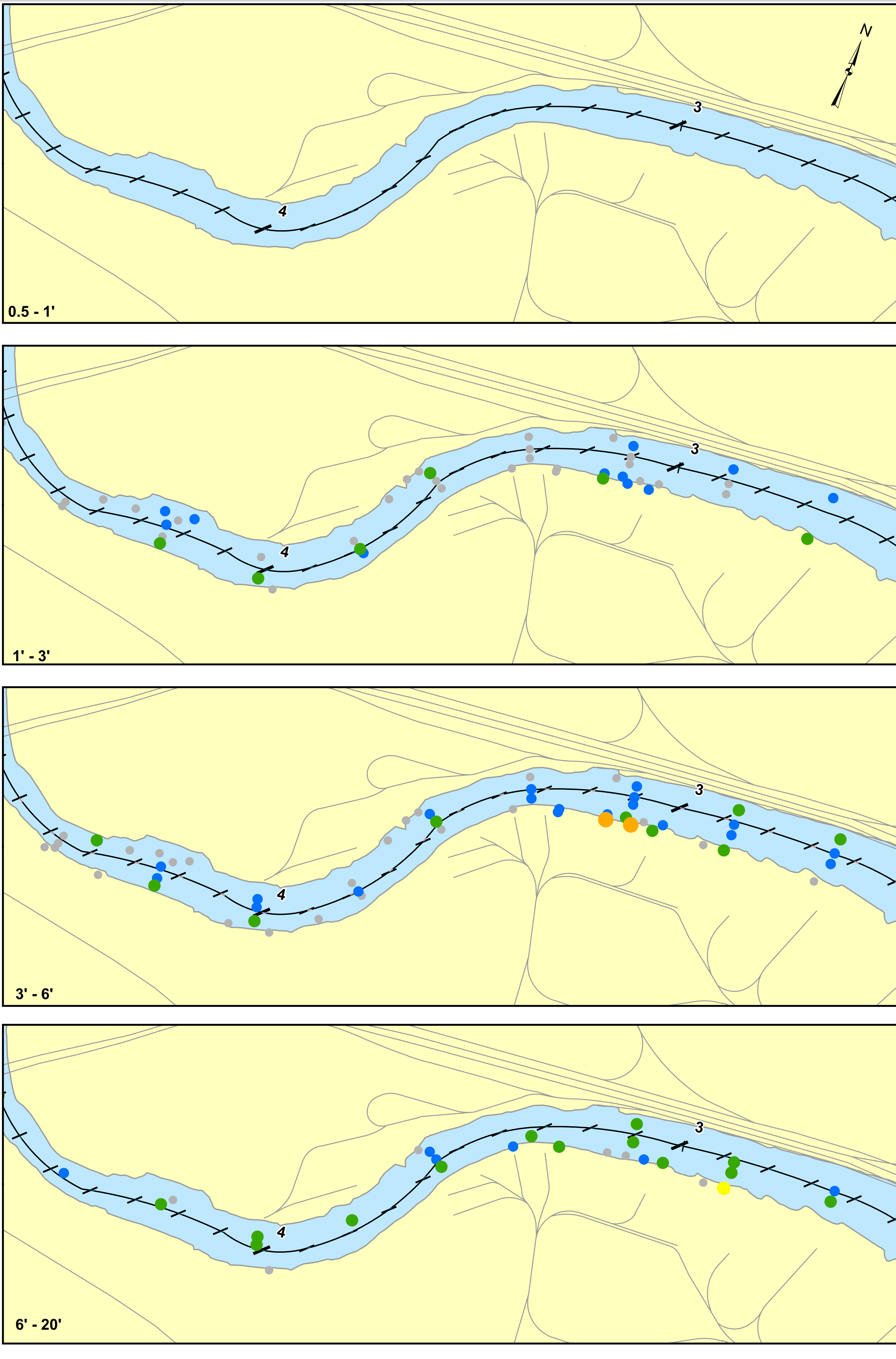


Dioxin Toxic Equivalency Quotients (PPB)

- 0.0025 - 0.5
- 0.5 - 1
- 1 - 3
- 3 - 7
- 7 - 14

Lower Passaic River Restoration Project
Surficial Sediments
Figure 3-33



Miles
0 0.25 0.5 1

Dioxin Toxic Equivalency Quotients (PPB)

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000

Lower Passaic River Restoration Project
Subsurface Sediment
Harrison Reach Figure 3-34

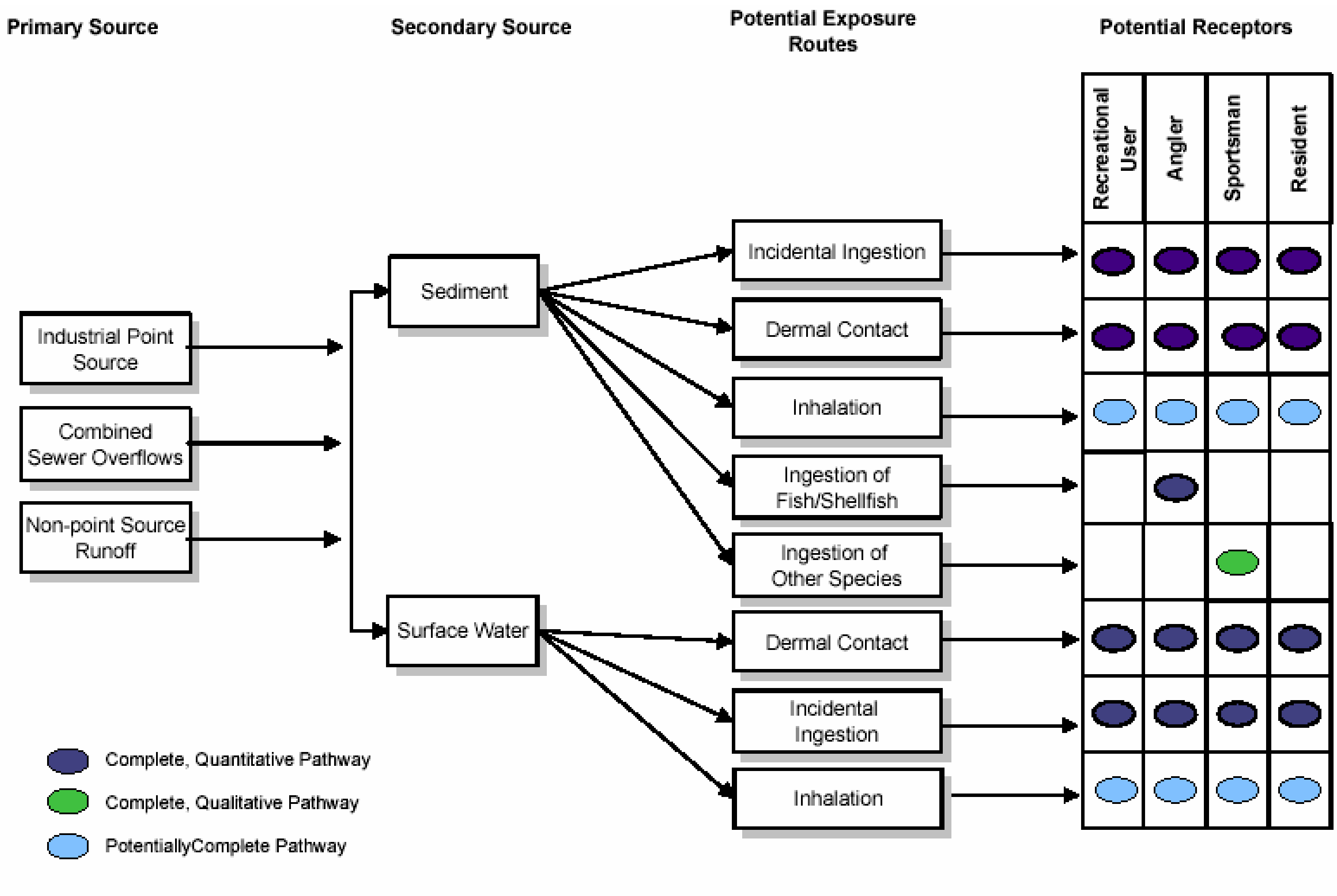


Figure 4-1
Lower Passaic River Restoration Project
Human Health Conceptual Site Model

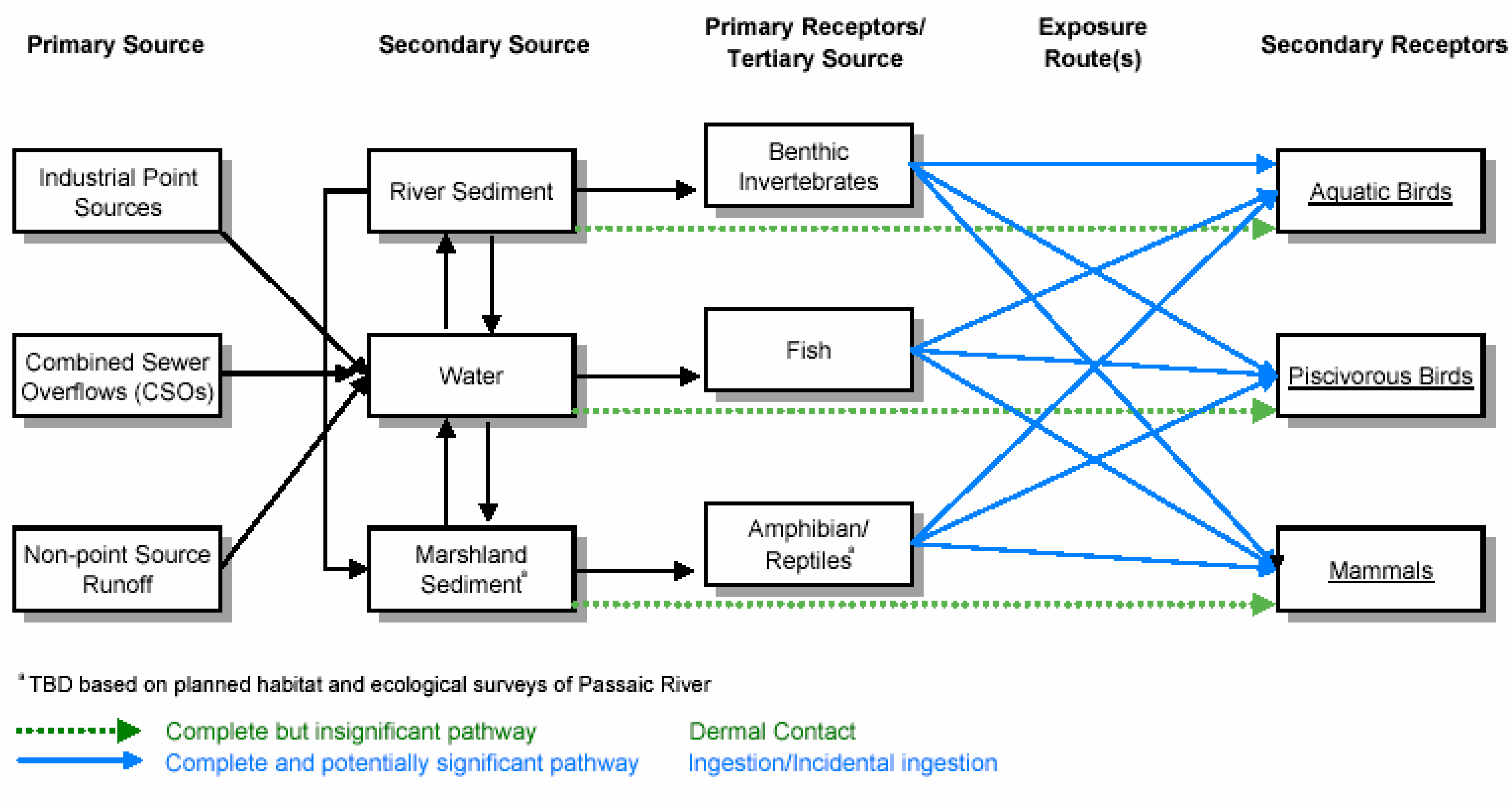


Figure 4-2
Lower Passaic River Restoration Project
Ecological Conceptual Site Model

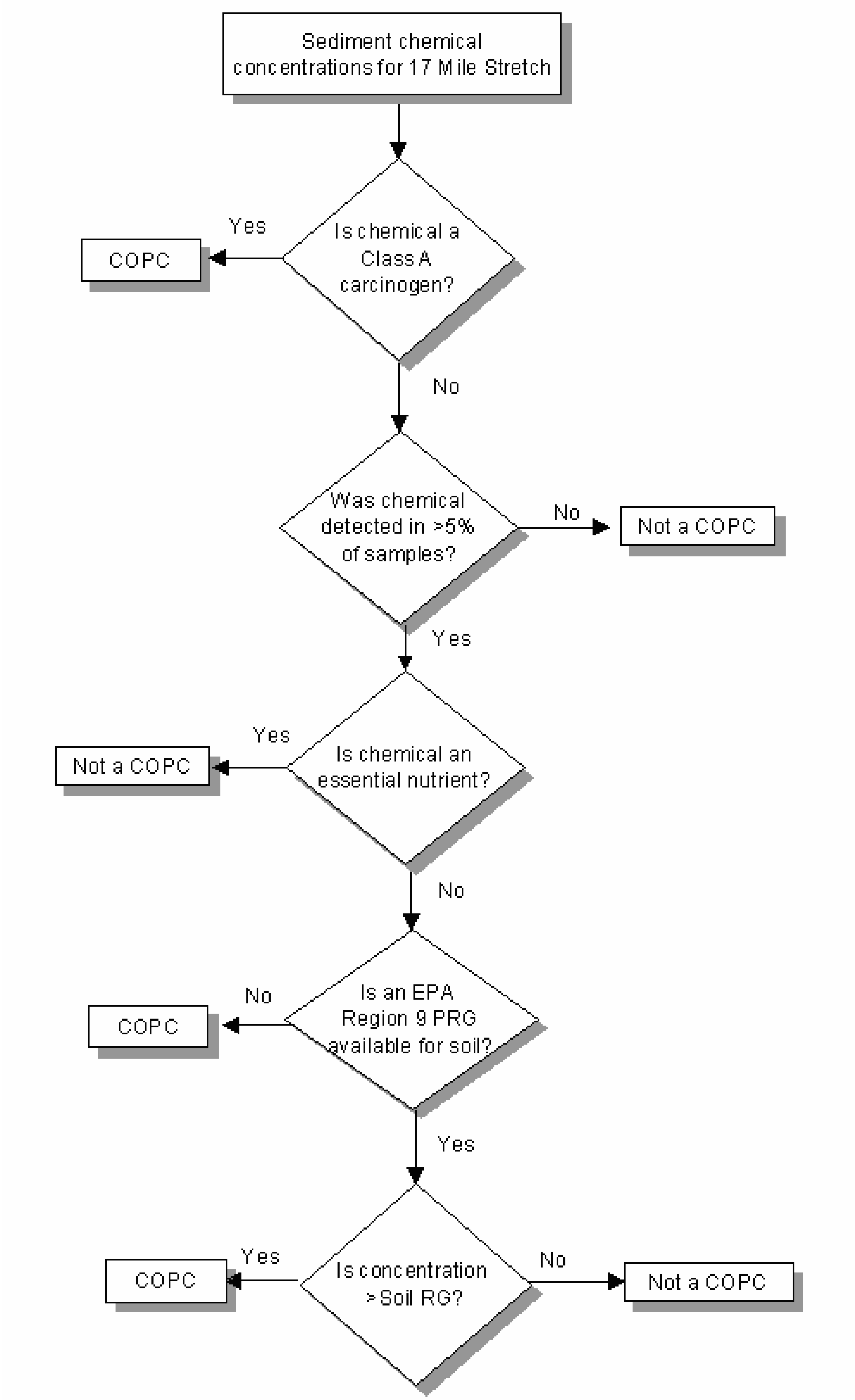


Figure 5-1
Lower Passaic River Restoration Project
Sediment COPC Decision Diagram for Passaic River Human Health Risk Assessment

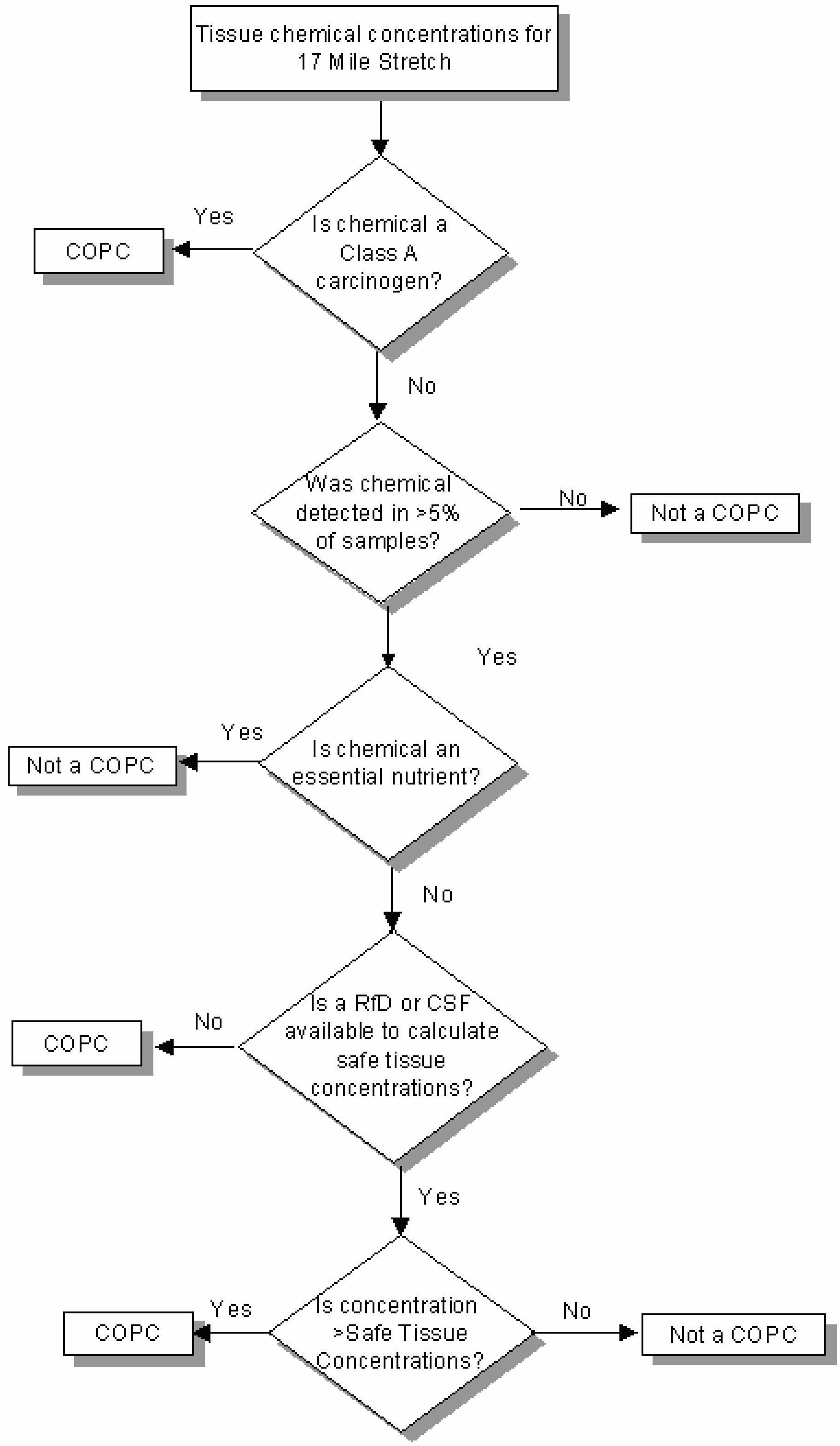


Figure 5-2
Lower Passaic River Restoration Project
Tissue COPC Decision Diagram for Passaic River Human Health Risk Assessment

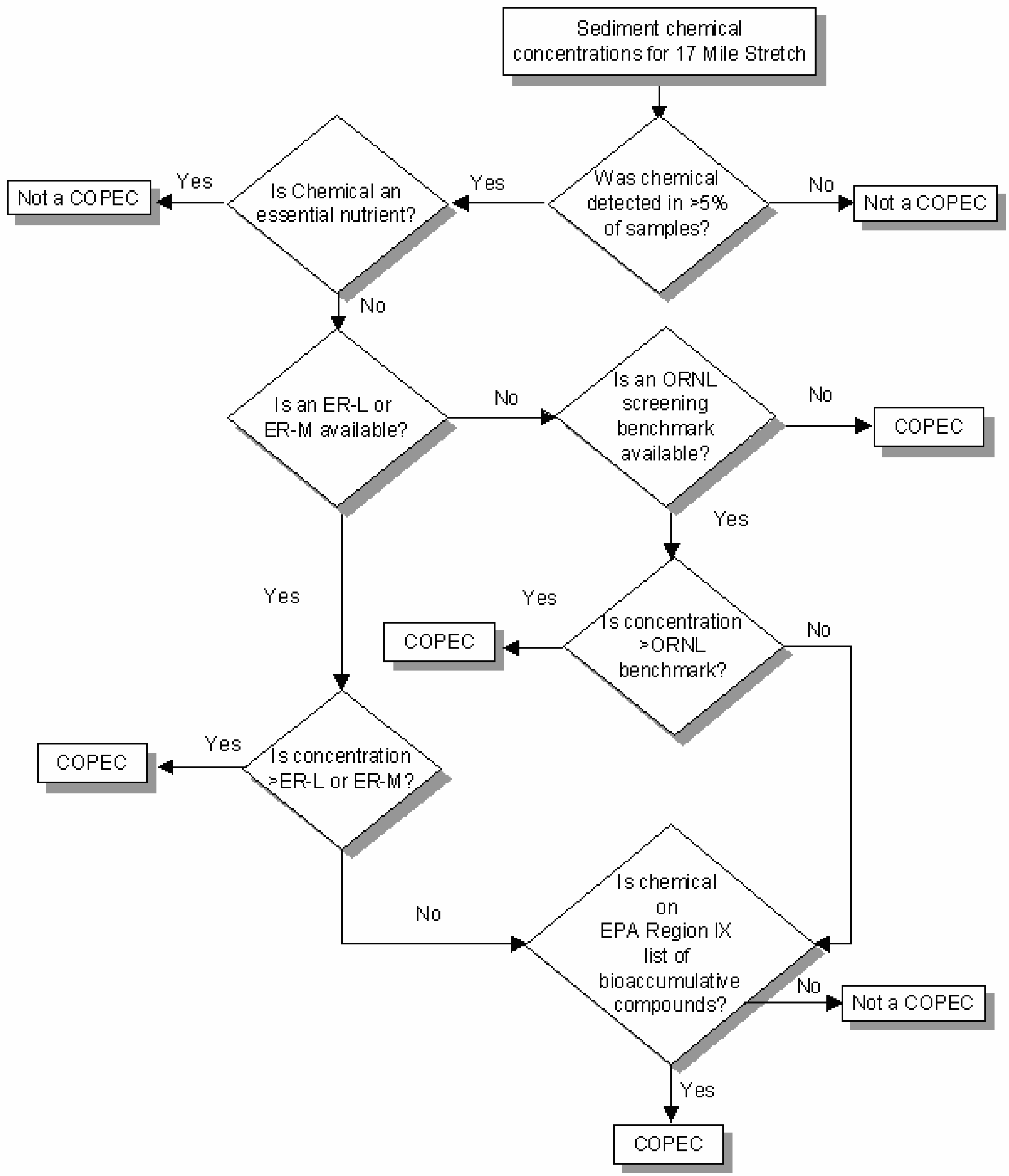


Figure 5-3
Lower Passaic River Restoration Project
Sediment COPC Decision Diagram for the Passaic River Ecological Risk Assessment

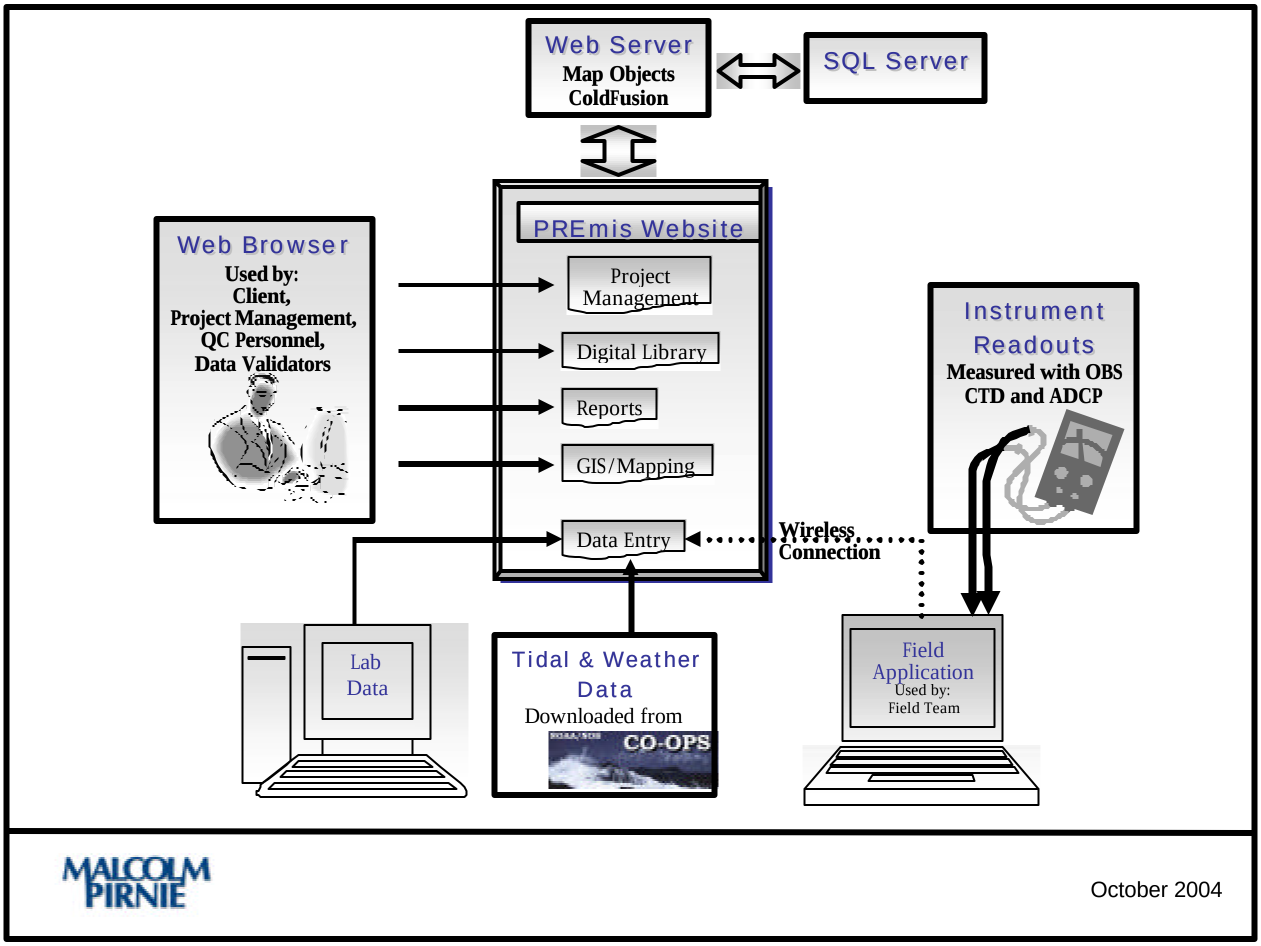


Figure 6-1
Lower Passaic River Restoration Project
Data Presentation Flow Chart

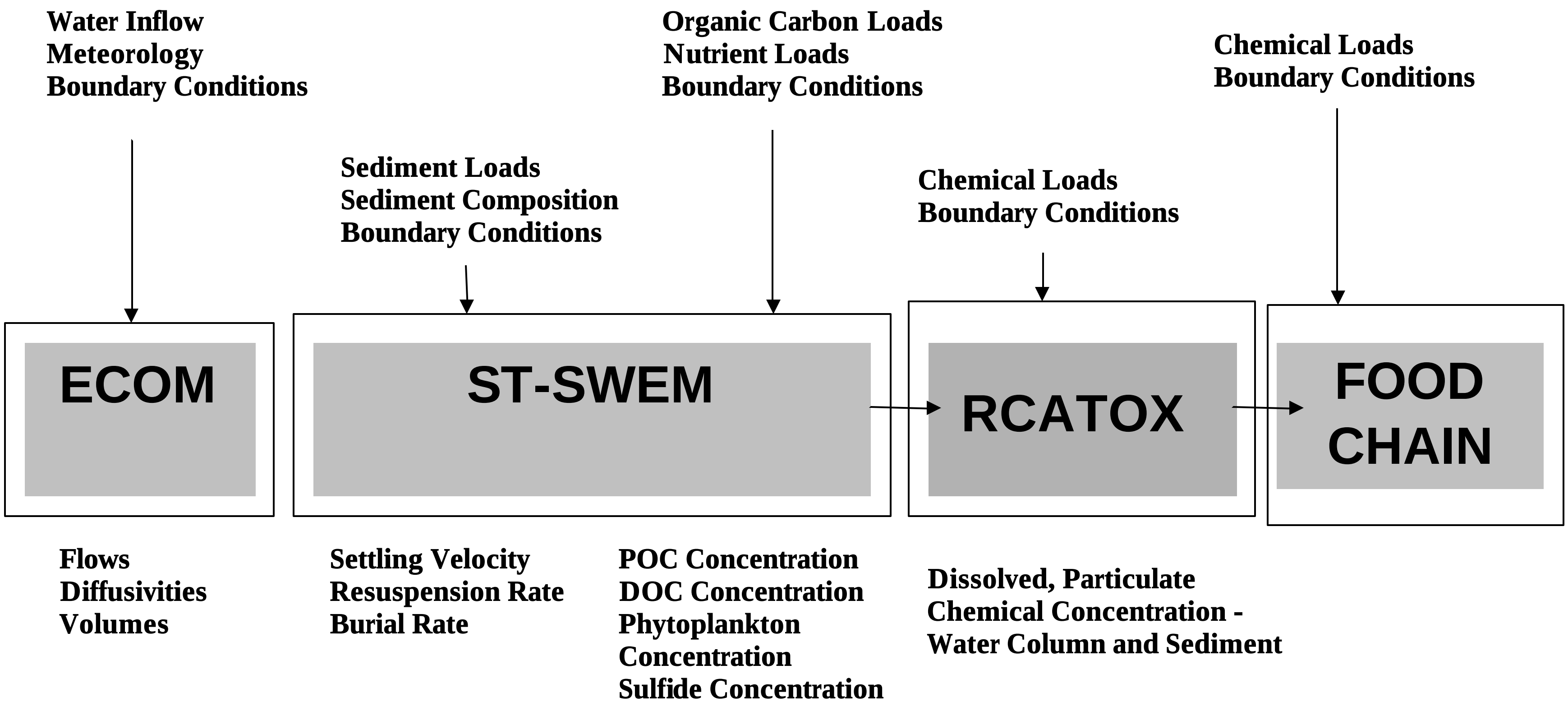


Figure 7-1
Lower Passaic River Restoration Project
Model Framework